SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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Original Correspondence.

THE JARROW IRON AND SHIPBUILDING WORKS.

he works of Palmer's Shipbuilding and Iron Company comprise Jarrow Works, situated three miles from the mouth of the Tyne; Howdon Yard, on the opposite bank of the river; two blast-naces and coke-ovens at Wallsend, which are not in operation; Port Mulgrave, in Yorkshire, where the ironstone mines are situ-. The Jarrow Works were commenced, and for some years car-on, under the firm of Palmer Brothers and Co. In the year 1852 building and engine-making was commenced, in 1857 the blast-naces were built, and in 1859 the rolling-mills were added. In the property, was transferred to a limited liability company, Mr. C. M. Palmer as its chairman and managing director. The d extension of their shipbuilding and iron trade made this change essary, in order to its complete development. These works have attained great magnitude: they contain within themselves every uisite for making iron ships of the largest class, fitting them with ines, and for their completion ready for sea. They now cover an of 98 acres, and employment is given in them to over 5000 per-. Eighteen years ago the population of Jarrow was not more n 600; at present the population of the town is about 22,000, ving a most remarkable and rapid increase, consequent on the blishment and extension of Palmer and Co.'s works.

he works are divided into six departments—viz.:

—The ironstone mines.

—The blast-furnace department, at which the manufacture of iron, kentledge, and rough castings of all descriptions is carried on.

—The forges and rolling-mills, producing angle-iron of all sizes, o 10 and 3 inches, round and squares to 5 inches, bulb iron up 0 inches deep, merchant bars, rails, and plates of all kinds.

—The engine-works, where marine and land engines, boilers, ings, iron and brass castings, and machinery of every descrip-is made.

—The iron shipyard at Jarrow.

—The bridge-building yard at Howdon, where all kinds of bridge is manufactured.

he ironstone to supply the blast-furnaces is derived principally the company's mines near Port Mulgrave, in Cleveland. About acres of mineral property is held under lease from Lord Nor-by and others. The quantity of ironstone brought to Jarrow is t 2500 tons per week. Two screw iron steamers, and other craft, constantly employed in the carriage of ironstone from Port Mul-e to the River Tyne, a distance of 40 miles. Two hydraulic es and three steam cranes are erected on the wharf at Jarrow, ransferring the ironstone from the vessels into wagons, and for ing or unloading other materials. The harbour at Port Mul-e was formed by Mr. Palmer, at a cost of upwards of 30,000*l.* separate beds of ironstone are worked at the Mulgrave mines. top bed is 4 ft. in thickness; between this and the bottom bed ft. of strata intervene, principally alum shale. The bottom bed ft. in thickness, including 1 ft. of shale associated with it.

LAST-FURNACES.—Four blast-furnaces were erected in 1857; e are all in action; they are 65 ft. in height, 19 ft. in diameter e boshes, and 9 ft. at the hearth; they are built of fire-brick, bound with iron bars. In the year 1860, the principle was ted of heating the stoves and boilers with the furnace gas; the f each furnace is closed on the cup and cone method, whereby se of coal for these purposes is entirely dispensed with. The is supplied to each furnace by an 18-in. pipe from the stoves, red outside, and a 16-in. circular main pipe, which is enclosed chamber formed around the furnace of wrought-iron. From main five tuyere pipes branch off at equi-distant points. The es are made with wrought-iron coiled pipes enclosed in cast-

The make of four furnaces is about 1600 tons per week, or ons per week for each furnace, principally No. 4 forge iron. and No. 3 qualities are also made. About two-thirds of the e make is utilised in the other departments of the works, the linder being sold. The Cleveland ironstone, mixed with Cum-and and Spanish hematite, is used in the furnaces; coke is used y for fuel; it is obtained from the collieries of Mr. John Bowes partners, and principally from Marley Hill; the limestone is ght from the quarries of Sir H. Williamson, near Monkwear-h, in the magnesian limestone formation. The analysis of one gives carbonate of limestone, 90·76 per cent.; carbonate of mag-, 6·99 per cent.; silica, alumina, and traces of iron, 2·25 per cent. teen stoves, with cast-iron pipes, are erected for heating the the temperature at the tuyeres varies from 900° to 1000°. Most e stoves are fitted with the double ∩ pipes, which have super-d the pistol pipes, formerly much used. There are 14 ∩ pipes ch stove, 17 ft. in length, placed in two rows; the passage in leg is 12 by 5 in., the blast must pass through seven double pipes, urteen 17 ft. lengths of passage before it makes its exit. This of pipe gives an increase of heating surface, as compared with pistol pipe, and an easier means of obtaining a temperature of , beyond which it is not thought advisable to heat the air with iron pipes. Each stove has a chimney of its own, unconnected the boiler chimneys. The blast was originally supplied to the aces by five blowing-engines on Slates' patent; these are now n action, they have been superseded by three large beam-engines. of these, built on the Tyne, has a 48-in. steam-cylinder, 108 blow-9-ft. stroke, 40 lbs. steam pressure, non-condensing; it has a ecting beam-head to work the fly-wheel; the valves are worked our bevel wheels and cams. No pumps are connected with it. boilers, 40 by 4½ ft., supply this engine; they are suspended from ed girders, the chimney is 100 ft. in height. Other two blowing-nes are erected in one house, on the west side of the furnaces; e were built at Lilleshall in 1865, they are the ordinary Boulton Watt beam-engine modified. The steam-cylinders are each 48-in., lowing-cylinder 100 in., 9-ft. stroke, 40 lbs. steam pressure, worked nsively; the engines have condensers and air-pumps connected em; these are not at present used. The beams are supported on der resting on the side walls and four cast-iron columns. The es are worked by four bevel wheels and cams. The beam-heads connecting-rods work to one fly-wheel, but the engines may be nnected, and worked singly; the pressure of blast varies from 4½ lbs. per inch.

elve boilers, 60 by 4 ft., supply these engines; each suspended from four arched girders. The boilers are heated entirely with gas. The boiler chimney is 130 ft. in height, 12 ft. in diameter at the top. The main gas tubes, by which the stoves and boilers are supplied, range from 5 to 7 ft. in diameter, and are without brick lining.

The Cleveland and other ore is raised from the wharf to the level of the Pontop Railway by means of an inclined plane, and engine with two 12-in. horizontal cylinders, 2-ft. stroke. This level coincides with the height of the calcining kilns, coke hopper, and lime-stone gantry, about 30 ft. vertically. There are 12 kilns for calcining stone, over these three lines of rails are laid; each kiln holds 90 tons of ironstone. The coke is all conveyed by the Pontop and Jarrow Railway, and is discharged into a hopper, containing when full 500 tons; underneath the coke barrows are filled from openings, which are closed by sluices. The ores, coke, and limestone are raised from the bottom to the top of the furnaces by an engine and inclined plane, rising at an angle of 45°. The engine has a pair of 12-in. horizontal cylinders, 2-ft. stroke, two 8-ft. drums, and round wire ropes, working on second motion. The barrows are placed on platform carriages, one ascends as the other decends. Two engines are fixed near the furnaces for pumping water, each has a 12-in. horizontal cylinder—one pumps from the river to a reservoir made on elevated ground, the other forces the waste water from the tuyeres to the reservoir; from this reservoir a supply is given to the blast-furnaces, forges and mills, boilers, and the hydraulic engine. The hydraulic engine has a 12-in. horizontal cylinder, 18-in. stroke, and works three force-pumps under an accumulator, which acts with a constant high pressure on the hydraulic machinery.

THE FORGES AND ROLLING MILLS.—There are two forge-engines; one has a 36-inch horizontal cylinder, 4-ft. stroke; the other has a 36-in. cylinder, 5-ft. stroke; they run at the rate of 45 strokes per minute. A train of four pairs of 22-inch puddling-rolls is connected to each engine, at one side of it. The rolls are driven at 45 revolutions per minute, by direct action, thus avoiding the use of a complexity of toothed wheels. A pair of cutting-down shears is attached to each train: 68 common puddling-furnaces are erected; a few of these are used as heating furnaces for scrap-iron. Two double puddling furnaces are worked by machinery, on Griffiths' patent; these have given satisfactory results. The machinery for each is driven by a small engine. The product of each patent furnace is 62 cwts. of iron in 12 hours, against 48 cwts. produced in two common furnaces in the same time. The consumption of fuel is 50 per cent. less in the patent furnace. The labour is as severe for the puddler, but lighter for the underhand than by the ordinary method. No difference is made in the prices paid per ton. There are five double-acting steam-hammers of 4 tons each, cylinders of 25 inches; these manipulate the puddled balls and hammer the piles of scrap-iron. The make of puddled bars is about 900 tons per week, exclusive of hammered scrap-iron. To supply the forge-engines and hammers with steam 18 vertical boilers are erected; the waste heat from the puddling-furnaces is utilised for heating them; usually four furnaces heat one boiler. The boiler-shell is 22 ft. in height, 9½ ft. in diameter; the tube is 4½ ft. in diameter, and about two-thirds the length of the shell; these are united near the top by four cross tubes 2 ft. 9 in. in diameter. On each quarter of the outside of the shell, where the flame from the furnace first impinges, there is an intense concentration of heat. This fact, and those boilers not being very accessible for examination have occasioned this type to be the subject of many accidents, and must always give great anxiety as to their safety. The heat about the puddling-furnaces at this season is very great; this is counteracted by throwing cold water about. Much of the heat is caused by flue cinder, which may be remedied in a measure by screening it or applying cold water, and parts of the furnaces might be covered with the object of preventing radiation of heat.

In proximity to the forges there are four rolling-mills, erected in one line; two of these are used exclusively for rolling ship and boiler plates; each of the plate-mills has two pairs of 22-in. rolls; the rolls are reversing; they are driven 34 revolutions per minute; the reversing is effected by means of a clutch and crabs. The two plate-mills are driven by a horizontal engine, with two 30-inch cylinders, 4-feet stroke, having one mill on each side of it. In connection with them there are 10 mill-furnaces. The production is about 460 tons of plates per week. Two large shears are erected for these mills, each driven by a single engine; the larger of these will cut plates 7 ft. in width, 1¼ inch in thickness. The engine makes 110 strokes, and the shears five cuts, per minute. The other pair of shears will cut plates 7 feet in width, ¾ in. in thickness. The third mill is a 12-in. bar-mill, with a 24-in. horizontal engine, and two pairs of rolls, driven at the rate of 110 revolutions per minute. The produce of this mill is 120 tons per week. There are two furnaces in connection with it, and one saw, driven by a rotary engine. The fourth mill has four pairs of rolls; they are driven by an engine with two 30-in. horizontal cylinders, 4-feet stroke, at the rate of 38 revolutions per minute; this is also a reversing-mill, and is used for rolling plates or for bars and rails, as required; it produces 300 tons and upwards per week. There are in connection with it six heating furnaces, also punching and straightening presses for rails, one pair of large shears, similar to that last described, and two circular saws, each driven by a rotary engine or fan. The mill-engines are supplied with steam from eight vertical boilers, similar to those in the forges; each boiler receives heat from two furnaces; there are only two cross-tubes in them instead of four. In addition to these, four horizontal Lancashire boilers are required, fired with coal, each 36 ft. by 8½ ft. in the shell.

Five tank locomotives are employed in conveying materials between the blast-furnace and other departments, and in conveying slag to the tips. The gas works, erected on the west side of the furnaces, are capable of making 2,500,000 cubic feet of gas per month, which is distributed to each department of the Jarrow property.

THE IRON SHIP-BUILDING YARD.—As already stated, the building of ships at Jarrow Works commenced in the year 1852. At that time owing to the development of the railway system in the Midland and Southern Counties, the northern coal trade had become greatly injured. Coal was then carried to London from the Tyne altogether in sailing vessels, and the coalowners of this district found it difficult to compete with those in the Midland Counties, who possessed in railways a more expeditious and cheaper means of transit for their coal. It was at this period that Mr. Palmer commenced shipbuilding with the construction of the John Bowes, a screw-steamer, of 650 tons burthen; it was built so as to secure large carrying power, rapidity in loading and discharging, and moderate engine-power, with a small consumption of fuel. On the first voyage of this vessel it was loaded in the Tyne in four hours, sent to London, discharged in twenty-four hours; on the fifth day from its departure from the Tyne it was back again, ready to take another cargo. At the end of the year 1854, thirteen screw-steamers and other vessels had been launched, and the construction of marine engines was commenced. In 1856 the large iron-cased floating battery, the Terror, was built in about three months, for the British Government, its tonnage was 2000 tons, the engines were of 250 horse-power, and the battery carried twenty-six 68-pounder guns. This vessel was covered with rolled armour-plates, instead of forged ones, since that time rolled plates have been exclusively used for plating vessels of war. In 1865, the graving dock was built, and is the largest on this coast; its length is 440 ft., depth of water, 18 ft. at ordinary spring tides, and 15 ft. at neap tides.

From the commencement in 1852 to the end of the year 1868, there had been launched 239 vessels, of an aggregate burthen of 205,419 tons, and engines have been made amounting to 27,399 horse-power. The most notable of these are the Terror (iron-plated battery), 2000 tons; the Defence, an iron-plated frigate, 3688 tons; the Jumma, a troop-ship, of 4173 tons, for the British Government, and the following steamers for transatlantic lines:—

	Tons.	Horse-power.		Tons.	Horse-power.
Georgia	2876	300	Scotland	3698	400
Virginia	2887	300	England	3307	400
Pennsylvania	2990	300	Nebraska	3336	400
Louisiana	2166	300	Manhattan	2869	350
Erin	3318	350	Chicago	2912	350
Ontario	3315	350	Minnesota	2887	350
Helvetia	3318	350	Colorado	2929	350

Since that period the Cerberus, an iron-plated monitor, of 2107 tons, has been built for the British Navy. This vessel is plated with 9-in. armour-plates for a depth of 7 ft. 4 in.; the turret is cased with 10-in. plates. The ship has only one hatchway—a solid tube of iron. It is propelled with twin-screws, and steered with a hanging rudder. The Nevada and Idaho have lately been built for the transatlantic trade. Each of these is 380 feet in length, 3125 tons burthen, and 350-horse power. The consumption of fuel in these steamers will be about 45 tons per day in each, giving a remarkable economy of fuel as compared with some other steam-vessels. At the present time six iron vessels are in course of construction; one of these is a steam-ram, which is to be named the Triumph. It will carry a powerful battery of guns of large calibre, and several new features have been introduced in its building, which promise to make it most efficient as a vessel of war, both in offensive and defensive operations.

The engine works department comprises most extensive buildings—pattern, smiths', and machine shops, the latter containing 110 machines of various kinds; an erecting shop, also containing many machines, and forge with several hammers, of which the heaviest is 7 tons. Adjacent to these is a very large foundry, the boiler makers' shop, and extensive sheds for rivet making.

NOTES ON CONTINENTAL MINING—No. X.

GERMAN MINERS AND SMELTERS.

For one or two facts in reference to the habits and wages of German workmen we are indebted to a very interesting description, by the Editor of the "Quarterly Journal of Science," of a tour recently undertaken by him among German operatives; also, for certain educational statistics we have the authority of the report of the French Royal Commission on Technical Education; and for additional facts private information has been kindly supplied by M. St. Paul de Sinçay, of the Vieille Montagne Company.

In travelling amongst the mining towns of Germany, perhaps the most striking feature to an Englisheye is the exclusiveness with which they seem devoted to that one industry. The entire population appears to be either miners, or those employed in superintending their operations, or in ministering to their wants. In dress we observed no peculiarity, save that of a small leathern apron, which the miner fastens on behind. Its use will be readily understood by those who have gone down the narrow shafts and along the tortuous passages of German metal mines. The lamps are everywhere on the same pattern, consisting of a slightly hollowed cup in the classical style, with a diameter of 5 inches, and furnished with a swan-neck handle, suitable for being carried in the hand or being suspended while the miner was at work. In the hollow of the lamp a quantity of solid fat is placed, which is gradually liquified by the heat, and consumed at the wick. To prevent the flame from spreading down the wick a small plate of tin fits on the lip of the lamp, and keeps the flame at the extremity; this piece of tin serves, also, to trim the wick occasionally.

The presence of a strong middle-class in our social constitution is usually adduced as matter of congratulation by Englishmen; but in this country we can rarely meet with that cordiality of feeling and geniality of association which characterise the leisure hours of the continental artizan. Throughout the towns we visited, when the labours of the day were ended, the populace seemed to turn out *en masse* to the parks and public gardens of the towns, and to mingle with each other, and with their superiors, in the most unrestrained and graceful manner. No shouting or boisterous merriment—scarcely a *gend'arme* to preserve order; nobody tramples on the flower-beds, or throws stones into the fish-ponds. Here the working man enjoys his Bavarian, while at the next table his employer sips Burgundy. Far from engendering disrespect, this course serves to cement those kindly and sympathetic feelings which should ever exist between capital and labour. In the parks at Antwerp and Brussels, sauntering through the exquisite grounds of Wiesbaden or Frankfort, promenading in the trim gardens of Hanover, or steaming round the brimming Alster at Hamburg—the entire absence of any exhibition of *caste* feeling between the upper and working classes gave an air of cordiality to the one, and of refinement to the other, alike beneficial and creditable to both. It is said that the intoxication of the English workman is a never-failing source of wonder to foreigners, but we were certainly astonished at the vast quantities of beer which the Germans consume; but it is likewise only fair to add that we saw but two persons tipsy during our travels. This is accounted for from the nature of the beer; it is thin and cheap. In most places the men pay a penny per quart. In a small town near Gottingen, at a weekly *reunion* of a body of miners, at which we were invited guests, a total quantity of five gallons of beer was consumed by 21 persons; and we were informed by one of their number that though these convivial gatherings were frequent it was very rare that anyone was unable to be at his post in the mine at 5 o'clock the next morning.

The average wages of the Hartz miners are 20 silber groschen pe-

day of 12 hours, equal to 12s. per week. Carpenters, masons, and blacksmiths employed about the mines earn the same, whilst in the smelting works the rate was more varied according to the nature of the employment, the chief man in each operation, as the head dresser, the head buddler, &c., getting double as much as his subordinates. Though the actual amount of wage is small compared to English earnings, if we look at the cost of provisions and rent in various countries it will be seen to preserve a very marked and uniform ratio to the wages of the operative. The average cost of 1 lb. of bread, 1 lb. of meat, one quart of beer, and one week's rent amounts, according to Mr. Samuelson, in—

		Average wages.	Ratio p. cent.
England	6s. 9d.	29s. 9d.	22
Dusseldorf coal field	3 8	17 6	21
South Germany	2 6	10 4	24
Hartz Mountains	2 10	14 0	21½

Thus showing that the relative proportion of cost of food and wages varies only within very narrow limits. The miners of the Hartz, however, seldom eat flesh meat; their chief sustenance is bread and sausage, called "wurst," whose praises one can hear chanted by every second or third man one meets with.

In speaking of the social position and resources of the German workmen, it is needful to glance at the educational arrangements of the country, and particularly as to the employment of children. Throughout Germany children under 12 are not allowed to work, but are compelled, under fine, to attend the primary schools from the age of six, in some parts, up to 14 years. The number actually attending schools is 97·4 per cent. of the children between those ages. The school fees, which are very low, are only charged where the parents are able to pay. The public expenditure for education in Prussia is 1·4 per cent. of the whole national outlay, while in France it is 1·1, in Bavaria 2·2, in Hanover 1·3, and in Wurtemburg, 4·7. In Germany great attention is paid to night classes and Sunday schools. The latter are, however, by no means the exact counterpart of the English institutions under the same name. The following is the prescribed routine of instruction for the first year in the Prussian Sunday and night schools:—Mensuration, four class hours per week; algebra to quadratic equations, three; practical arithmetic, four; physics, four; chemistry, four; free-hand drawing, seven; linear drawing, nine class hours per week. Prussia has 25 of these trade and improvement schools established, one-quarter of whose support is derived from the pupils' fees, and the rest of their income from the towns where they are held, and from the State jointly. In the kingdom of Hanover there are 37 such schools for apprentices and workmen. That at Gottingen is one of the largest, numbering 328 pupils, of whom 316 are *bona fide* apprentices or artizans. We had not an opportunity of seeing the classes actually at work. The Prussian regulations with respect to the employment of children are very strict, though, as far as our own observation went, they seemed to be less rigidly enforced in some of the outlying villages of the mountainous districts. The report of the French Commission states, with regard to the employment of juvenile labour in North Germany, that "children cannot be allowed to work in factories until full 12 years of age. Young persons under 16 cannot be admitted to work in factories until their father or guardian shall have presented a pass-book containing the day, month, and year of the holder's birth, and stating his religion, the name, profession, and domicile of his father or guardian, and a certificate stating that he can read and write. The manufacturer is to keep this pass-book, show it to the authorities whenever required, and return it to the parent or guardian when the young man leaves his service. Children under 14 years of age cannot be compelled to work above six hours per day. Three hours per day must be devoted to school. It is absolutely forbidden to make children under 16 work before five in the morning or later than half-past eight at night. All persons who employ children under these conditions are bound to give notice thereof to the police authorities, and to make a return every half-year of the number of young people under 16 years of age in their employment. Infringements of these regulations are punished by fines. Wages must be paid to the parents."

One of the most vital questions to the prosperity of a mining district, and one that has been strangely neglected hitherto in this country, is the thorough and scientific education of mining engineers. It is true the Royal School of Mines in Jermyn-street is equal to any in Germany, but one central and expensive establishment can never adequately supply the wide-spread demand of the English mining interest. We visited the Mining School at Clausthal, the centre and capital of the Hartz mineral district. The instruction is comprised in lectures on physics, chemistry, mineralogy, mining, and metallurgy, and in a practical course of labour in the mines and dressing-works for a short period in each year. The director-in-chief, Herr Von Groddeck, courteously gave us an account of the instruction in the academy, and exhibited the extensive collection of minerals and ores, crystallographic forms, plans and sections of mining ground, working models of machinery, and specimens of ores in the various stages of preparation, with which this institution is so liberally supplied. There are laboratories for the dry and humid assay. Various other mining schools exist in North Germany, and we cannot more appropriately close this brief account than by quoting from the French report on technical education a passage descriptive of the Prussian School of Mines at Berlin. "The mining pupils who wish to enter the service of the State have three degrees to acquire by examinations. The first, which is given on leaving the school is that of pupil of mines (*elere des mines*). The second, which can only be obtained after two years' practical working, leads to the title of auditor of mines (*referendaire des mines*). The third, for which no one can present himself till after two years passed in administrative works under a chief engineer, gives the title of assessor of mines. The school fees are calculated at the rate of 1½ thaler (4s. 6d.) for an hour's lesson attended per week. Thus a pupil who attends a course for which there are six hours' lessons per week pays 9 thalers (27s.) per half-yearly term. For manipulations in the laboratory they pay in addition 20 thalers per term, and 10 thalers if they practise assaying. The number of pupils varies from 30 to 40, and the total expense of the establishment amounts to 12,000 thalers. The amount not covered by the receipts is paid by the Government, which has also found the building and all its furniture, as well as the collections. There are nine professors, three of whom are specially attached to the school, and receive a salary of 150*l*." All the instruction is given in the German language.

JOINT MEETINGS OF ENGINEERS AND SHIPBUILDERS AT GLASGOW—No. II.

SIR,—With respect to the probable formation of the Low Main Seam, in Northumberland, referred to in my letter published in the Supplement to the Journal of Aug. 27, I may remark that vegetable remains are found very frequently, and in great abundance, in the shales associated with that coal seam; and, what is remarkable, their remains appear to be more plentiful in the shales above and below the lower seams than in the upper measures. This is thought by some to be against the idea that this seam (the Low Main) has been formed by deposition, but I hope that some of your readers, acquainted with the geology of the district, will throw some light on this difficult subject.

The next paper, on the "Rosedale Ironstone," presents much interest. This remarkable deposit of iron ore, which is magnetic, entirely differs from any other deposit in the Yorkshire district; and I recollect that when the late Mr. Bewick wrote a very able paper on this subject, some years ago, his theory that it was of igneous origin was eagerly accepted; indeed, this theory appears to be the only one capable of accounting for all the circumstances of the case. But it must be remarked that when Mr. Bewick and Mr. Wood wrote on this subject all the explorations that had been made by means of bore-holes and drifts appeared to show that the formation of magnetic iron ore was of immense area and thickness; but since that time further driftings have proved that these views were fallacious. It was expected from the section shown in these bore-holes that the deposit extended in one direction two miles. In fact, it was an enormous quarry of iron ore, of great value, but the dimensions are now shown to be only about one-fifth of the area orignally expected; and with respect to the nature of the deposit, its igneous origin is denied, on the ground that fossil trees and vegetable remains are found, which could not have been preserved if volcanic action had taken place.

The next paper, that of Mr. Simpson, on "Cornish and other Pumping Engines for Draining Mines," naturally has the greatest possible interest for all connected with mines. The Cornish engine is compared with all the varieties of engines in use for drawing water from mines; and to show that while the ordinary consumption of coal by the pumping engines of this district (that is, the average, calculated from data given by Mr. Simpson) is 14 lbs. per horse-power per hour, the consumption of coal by the Cornish engine is only 3·6 lbs. per horse-power per hour. He assumes that if the consumption of coal were reduced to 4 lbs. per horse-power per hour the saving of coals in the district would be enormous, as the total horse-power used for raising water in the Newcastle district is assumed to be about 10,000. It must, however, be borne in mind that the Cornish engines and boilers can only be erected by expending a good deal of extra money in the first instance, as compared with other engines and boilers in use, although the cost would, there is no doubt, be repaid ultimately in some cases.

In the very interesting discussion which took place after the reading of Mr. Simpson's paper, Mr. Stevenson (Airdre) said that—

"His idea was that the best kind of engine was one with an up and down stroke, not one doing work with one half stroke, and then presently undoing it with the other half. . . . . The horizontal engine was the best, if they could get greater speed in the piston, and that had recently been obtained by making one end of the bell crank double that of the other."

It appears that the compound high and low pressure engines possess great merit, and are, perhaps, all things considered, the best engines yet brought forward. They have, it appears, been worked with great economy, so far as the consumption of coal is concerned, 1·99 lbs. per horse-power per hour being the effective duty.

There is no doubt that the Cornish engine consumes less fuel relatively than any other, yet it is not at all likely that it will ever be generally adopted for use in collieries: its motion is too slow, and necessarily a large plant, an expensive engine, boilers, and pumps are required when it is used. With respect to speed, and the quantity of water raised, it is evident that, supposing (say) 400 gallons of water per minute to be raised 80 fms., this can be done by a double horizontal engine, working two double-acting pumps, at 35 revolutions per minute. And the cost of this engine, pumps, and all necessary appliances would not exceed (say) 1000*l*.; whilst the cost of a Cornish engine, pumps, and all other appliances would certainly be much larger, probably at least three times that amount. The question of first cost is, therefore, a very important one; and if the consumption of coal can be reduced, and an engine obtained capable of running at a high rate of speed, and also capable of working at various rates of speed, as the water met with may be increased or decreased at various times, this engine appears to be the most simple and effective.

From the paper of Mr. Simpson, and the discussion thereon, much may be learnt, and the most useful lessons may, perhaps, be summarised thus:—The boilers and pipes, and also cylinders, ought in all cases to be well covered with some non-conducting substance; the slides ought to be carefully adjusted; and there appears to be no reason why all engines, or nearly so, should not be worked on the expansive principle. In order to effect this it is only necessary to work with good boilers, at a high pressure, and to employ cylinders a little larger than would otherwise be necessary. And also the boiler power employed is worthy of attention—that is, with reference to ample boiler power, it is justly remarked that great economy results from this. When the boiler power is defective rapid firing cannot be avoided, and great waste of coal, destruction of boilers, and also danger are the result. M. E.

Newcastle.

MECHANICAL VENTILATION.

SIR,—During the discussion on this important subject at the meeting of Engineers, &c., at Glasgow, and which is given in the Supplement to the Journal of Aug. 27, wherein Mr. Simpson described a Guibal fan of 16 ft. diameter, driven by an 8-in. cylinder, by which he gets 36,000 cubic feet of air per minute, with a water-gauge of ½ in. Perhaps Mr. Simpson would be kind enough, for the benefit of your readers interested in this matter, to state, through the Journal, the width of fan, the number of revolutions of fan per minute, the length of stroke of the engine, and if the engine makes one double stroke per revolution of the fan, the pressure of steam in the boiler, and if the water-guage is taken at the inlet of the fan; also, the indicated pressure on piston, if he has taken it.

INTERESTED IN FANS.

THE METALS AND THEIR ORES—No. XI.

SIR,—It appears that, owing to a postal irregularity, article No. XI. did not reach you—hence the delay in its appearance.

GOLD.—This, the noblest of metals, is invariably found in its native or metallic state in the form of scales, grains, fibres, and rounded masses or nuggets, and is found occasionally beautifully crystallised in cubes and octahedrons, or other forms belonging to the cubic series. It is, however, seldom met with absolutely pure, being usually alloyed with a proportion of silver varying in quantity from a mere trace to upwards of 40 per cent.; and native gold is also occasionally more or less alloyed with the metals copper, iron, palladium, and rhodium. When pure, gold has a specific gravity of 19·3, and then possesses its characteristic brilliant yellow colour, but when alloyed with silver or other inferior metals its specific gravity is proportionately reduced, and its colonr and hardness are modified. When hammered into thin plates or leaves the metal transmits a green light. Gold fuses at 2016° Fahr.; at higher temperatures it is sensibly volatile, and by the intense heat of the electric battery it may be completely dissipated in vapour. It is not otherwise materially altered by heat. It is not tarnised by exposure to air or moisture, neither does water, sulphur, or any simple acid act upon it, but it is dissolved by a mixture of the nitric and hydrochloric acids. Gold is the most malleable and ductile of all the metals, enjoying those properties to an extreme degree. This quality must have been well understood by the ancients, as we are told in the sacred writings that "the ark of shittim wood was coated with gold both on the outside and the inside." The Egyptians were accustomed to gild wood and metals, and Solomon caused various parts of the temple to be overlaid with gold. Pliny, in his natural history of the world, says of gold "neither is there any metal which can be beaten out broader by the hammer, or divided more easily into parcels, as every ounce of it may be reduced into more than 750 leaves, each one of which being four fingers square." Pliny also states that gold leaf was applied to marble with a varnish; and Lucretius compared the Roman gold leaf to a spider's web. In our day it is not unusual for a single grain of gold to be beaten into a leaf containing 56 square inches, or having a thickness of 1-200,000th of an inch, or to be drawn into a wire 700 feet long. The two last, combined with its other useful qualities, cause gold to be in modern, as it has always been in ancient, times a most beautiful and economic decorative substance. In my next paper to the Journal it is my intention to describe other interesting properties belonging to this important and fascinating metal. E. GLEDHILL.

Mining offices, Shrewsbury, Sept. 5.

TIN IN QUARTZ.

SIR,—In the Journal of Aug. 27 a letter appears on the subject of Tin in Quartz, and as the remarks therein are attracting unfavourable attention to the Reperry Mine, I shall be glad if you will publish this letter in your valuable columns; and I hope it will allay any fear that may have arisen in the mind of any shareholder in the company.

The lode of the Reperry Mine is situate the same as all the greatest tin mines in Cornwall, and the tinstone itself is so like that of Great Wheal Vor, that Capt. Tonkin, late of Royalton, thought it was from that mine when shown him. Assays of the lode at 15 fms., and also from the branches which have crossed the shaft at still deeper points, have been made, and not a trace of wolfram appears; and, also, the deeper the branch is the greater the proportion of tin and less oxide of iron is shown. We have also another more incontestable proof, and that is the old company raised from a few fathoms driving in the 15 fm. level no less than 4 tons of tin, which sold for between 70*l*. and 77*l*. per ton to Messrs. Martin and Co., of St. Austell. This was stamped out in two months, and with only four heads of stamps at work. We have now a very much richer lode, and also stamping and pumping power enough to carry us nearly 100 fms. from surface. We expect to cut the north lode 25 fms. from surface in one month from this date; and when this is done I will send you samples, for the satisfaction of yourself and your readers. G. H. POULTON.

Torquay, Sept. 5.

[ADVERTISEMENT.]

VIRTUOUS LADY, AND QUEEN MINES.

VIRTUOUS LADY.

SIR,—I notice, in the Mining Notabilia in last week's Journal a statement made by a correspondent, not giving his name, that "the Virtuous Lady Mine is now bringing to surface piles of the finest copper ore," &c. I have not the slightest idea of the name of your informant, who, no doubt, wishes me and the mine well, and has simply spoken the truth, for which I return the unknown many thanks; but, at the same time, I would request that nothing further be said respecting the discoveries at the mine, unless the writers are disposed to sign their real names. The shareholders have every facility of seeing the reports from our agent in your columns, and the mine requires no comments from obscure writers. It is now sometime since I appeared in print upon the subject of this property; but my opinion of it I should think is pretty well generally known from my strong statements made at the early part of this year; and, although the great success anticipated by me has not yet been achieved, I have never had the least wish to qualify my outspoken and honest, if not correct, predictions, founded upon practical observations. Discretion, they tell me, is the better part of valour—so I thought it wise when the mine was poor to hold my tongue, simply because I knew then I should, for the time, get the worst of the argument, and, therefore, reconciled myself to keep quiet, and wait the tide of events. The time of my great triumph is, I believe, approaching—not a single point that I aimed at for success has yet been reached; but if the battle has not yet been won, it certainly is not lost, and most assuredly, though slowly, we are with safety nearing the eve of success. The outside public I know imagine the Virtuous Lady is dying a natural death, or dragging out a miserable existence, and think that my silence is in acknowledgment of my defeat. Poor deluded creatures! they little know me and my genuine faith to suppose that, even if in trouble, I should desert my first love. Nay; there has been quietude, but no idleness going on; and, in order to secure against all contingencies, hopes deferred, and casualties, the capital has, long before it is wanted, been increased, and an additional 5000*l*. cash to work the mine arranged for, independent of which an extensive sett has been added, making the Virtuous Lady Mine property nearly three miles in length, abounding with unexplored mineral deposits. Already a tin lode is being worked, and returning rich tinstuff, second to very few in the country. A water-wheel and stamps are being erected, and soon after they are started we shall be able to dispose of our first and far from insignificant batch of tin. Nay, my most illustrious friends, the "bears," I acknowledge you have, assisted by the war, bested me in some stocks and funds into which I went rather heavily, recommended to me by some well-meaning friends, who, in their anxiety for my welfare, were not happy until I had tried my fortune in a *certainty*, as they termed it; however, in mining, and with the valuable properties I bring before the world, I am more than your match—and, with all due respect to my well-meaning friends, I prefer the uncertainties of mining, even to my last penny, to the *certainties* so generously brought before my consideration. Mining is speculative, I allow; but when you get a profit it is worth having, and rather than go grovelling about in the dark with Three per Cents., Gutta-perchas and India-rubbers, Constructions, and Railways, when a dividend of 5 per cent. about to be declared is knocked all to splinters by one single accident. Give me mining, even if I have to risk the prospect of such a great change as ending my days either in the shape of a millionaire or in the workhouse. Your readers will, perhaps, feel interested in perusing Capt. Horswill's report in the Mining Correspondence.

THE QUEEN.—I have read Mr. Ennor's letter, which appeared in your columns last week, and, of course, it can be seen at once that he refers to this mine; however, as his slurs upon dividends, and silver being taken away from this district to other mines to rig the shares, have nothing to do with me or this property, or any person connected with it, his letter upon this point elicits no reply from me. He is quite correct about tin being one of the minerals upon the sett. We are quite aware of this fact, as well as himself. However, as for copper mundic not making copper in depth, it is simply a matter of opinion, and I consider Capt. Knott much better qualified to judge of the district than Mr. Ennor, to say nothing of the one general opinion of the numerous mining men who have visited the mine; and I am amply satisfied with copper mundic lodes for the present, worth 10*l*. to 12*l*. per fathom, that can be stoped at 45s., which yield a larger profit than almost any mine in England. We are perfectly convinced with Mr. Ennor that silver-ore of very rich quality is found in bunches or pockets, and not mountains, and shall endeavour to benefit by his advice, "If nests of silver are found, take them as silver"—we shall most assuredly not take them, and least of all sell them, for copper. His closing clause—"I believe there is a very wide field open on these very lodes for generations to come"—proves that he must, after all, have a very exalted opinion of the mine, albeit his remarks made some weeks since upon the property, and "the clever angler upon the banks of the Tamar," &c., tended to seriously depreciate it. I would advise Mr. Ennor, if he intends to preach a gratuitous sermon, to keep to his text, and if he must extemporise, as the order of the day, to be very wary of how he rambles, or he may find that, instead of his animated elocutionary discourses being listened to with pleasure, his would-be admirers will turn from him with ineffable disgust.

I shall feel obliged if you will insert the minutes of our quarterly meeting, and I have every reason to trust and believe that the next quarter will admit of our paying a still better dividend, to be gradually increased as the mine is prosecuted and developed, and thereby enabled to open up its mineral resources.

I am now open to sell 300 Queen shares, fully paid-up, at 2*l*. 7s. 6d. each, simply because I want money. I recollect a few years ago writing in my school-book—"An open confession is good for the soul." Granted, if you wish it; I, at least, have no doubt it will do good for my pocket, and I really cannot at present in England see a more profitable or safe investment at the price asked. Honest dividends paid out of pure profits must, of necessity, rule the value and prices of any mining shares, and, depend upon it, the Queen's will be sought after at 10*l*. before many months have passed. THOS. J. BARNARD.

Tamar House, Tavistock, Sept. 7.

WHEAL SETON, AND ITS MANAGEMENT.

SIR,—A letter in the *West Briton* of last week has taken me by surprise. Can it really be true? Is it possible that we have there such a person for our manager? If the letter should prove to be true such must be the case. Is this a sample of Cornish mine managers? So sure as it is proved to be true, or disproved—which must now be done—he will have to vacate his position, for no honest and legitimate mining company can allow themselves to be under the control of such a person.—*Old Broad-street, Sept. 5.* AN OLD ADVENTURER.

[For remainder of Original Correspondence see to-day's Journal.]

CORNISH PUMPING ENGINES.—The number of pumping-engines reported for July is 18. They have consumed 1381 tons of coal, and lifted 10·4 million tons of water 10 fms. high. The average duty of the whole is, therefore, 51,000,000 lbs., lifted 1 ft. high, by the consumption of 112 lbs. of coal. The following engines have exceeded the average duty:—

	Millions
Cargoll Mines—Michell's 72 in.	60·5
Chiverton Moor—70 in.	52·0
Dolcoath—85 in.	57·0
North Wheal Crofty—Trevenson's 80 in.	67·0
Providence Mines—40 in.	53·5
West Chiverton—Hawke's 80 in.	51·2
Ditto —New 80 in.	63·8
West Wheal Seton—Harvey's 85 in.	67·0
Wheal Seton—Tregonning's 70 in.	72·5

CUTTING COAL.—Mr. P. GLEDHILL, Newcastle-upon-Tyne, proposes to employ a frame mounted on wheels adapted to run upon rails. At one end of the frame and towards its outer side, and that at a distance from the coal or mineral to be cut, a horizontal cylinder is fixed; it is inclined towards the centre line of the frame. Within the cylinder is a piston actuated by air or other fluid pressure, and giving motion by a piston-rod and connecting rod to a cranked axis mounted vertically.

TESTING FOR GOLD.—It is proposed by Mr. SKEY, of Wellington, New Zealand, to ascertain the presence of gold in auriferous quartz by thoroughly crushing and calcining the stone, and then immersing it in a bath of iodine or bromine, and then burning filtering paper, saturated with the fluid in a muffle. If no gold be contained, the ashes will be perfectly white, but 1 dwt. to the ton will give a beautiful purple colour. Dr. Hector considers that experiments with baths containing known quantities of gold will permit the proportion to be determined by the tint of the ashes.

METALLINE.—The invention of Mr. S. GWYNN, New York, consists of a process of selecting, treating, compounding, and consolidating certain substances, by which are produced new compositions of matter (denominated by the inventor "metalline") designed for the purpose of journal boxes and other parts of machinery, and other articles whose surfaces in use are subjected to friction, and which substances possess such properties and conditions that in the practical use in machinery and elsewhere in the arts of such articles made of it so little friction is actually caused, and so little heat thereby evolved, that all necessity for the application of oil or any other lubricant is entirely obviated.

PREPARING ORES.—The invention of Mr. C. COCHRANE, Upper Gornal, consists in introducing the heated reducing gases into the chamber or kiln at a point situated some height above the discharge end of the kiln, while at such latter point the inventor introduces cool carbonic oxide or blast-furnace gas, which in rising up through the heated and partially or wholly reduced ore descending from the upper part of the kiln, where it has been subjected to the action of the heated gas, takes up the heat from such reduced ore, and also completes the reduction of any of the ore that may not be perfectly deoxidised, and the ascending carbonic oxide gas by thus becoming itself heated acts effectually together with the upper heated gas in reducing the upper strata of ore. The heat of the ore is thus utilised, and the ore discharged in a cool condition.

STEAM ENGINES.—Mr. E. WOOD, Bolton, proposes to employ three eccentrics, one for each steam valve, and the third for the exhaust. Two of hese eccentrics are connected by eccentric rods to two vertical working levers one to each steam-valve), the upper end of which carry catches which act upon he sliding spindle, which is provided with a "dash pot," and connected to the ever fixed on the spindle of the rolling steam valve. The end of the catch is furnished with a finger, which can be raised or lowered by means of a small roller, acted upon by levers and links connected to the governor rod. As either eccentric causes its vertical lever to vibrate the catch at the top pushes forward the sliding spindle and opens the valve. As the lever continues to move on, the finger of the catch engages the small rollar above named, and the catch is lifted clear of the spindle. A spring then closes the valve.

LONDON GENERAL OMNIBUS COMPANY.—The traffic receipts for the week ending September 4 was 10,191*l*. 17s. 8d.

THE IRON AND STEEL INSTITUTE.

MEETING AT MERTHYR.

The half-yearly general meeting of the Members of this Institute was held at Merthyr, on Tuesday and Wednesday, under the presidency of His Grace the DUKE OF DEVONSHIRE, when there was an unusually large and influential attendance. The business meetings were held at the Temperance Hall, and excursions were made in the afternoons to the neighbouring iron works, where the members were hospitably entertained. On Thursday, the members visited Swansea, and were invited to luncheon by the Mayor, and in the evening, on returning to Merthyr, were entertained at a magnificent banquet given by the Merthyr ironmasters. Friday was devoted to the Monmouthshire Iron Works, the Ebbw Vale Company entertaining the party most sumptuously. The following were among the company present:—His Grace the Duke of Devonshire, K.G.; Sir J. G. Alleyne, Bart.; Messrs. John Hartley, Wolverhampton; E. M. Richards, M.P., Swansea; I. Lowthian Bell, Washington; F. W. Kitson, Leeds; W. Menelaus, Dowlais; Walter Neilson, Glasgow; Josiah T. Smith, Barrow-in-Furness; Walter Williams, West Bromwich; G. Addenbrooke, Wednesbury; Chas. Baynal, Whitby; W. T. Crawshay, Merthyr Tydvil; R. Cassels, Glasgow; R. Fothergill, M.P., Aberdare; R. Heath, Stoke-on-Trent; T. E. Horton, Lilleshall; W. R. I. Hopkins, Middlesborough; E. Williams, Middlesborough; David Dale, Darlington; John Jones, Middlesborough; David Forbes, F.R.S., London; William Barrett, Stockton; Thos. Bell, Newcastle; John T. Bell, Sunderland; Henry Bessemer, London; Thos. S. Blair, Pittsburg, U.S.; J. J. Bodmer, Newport; Jas. Brogden, Bridgend; J. O. Butler, Leeds; Lord F. Cavendish, M.P., Holker Hall; Messrs. E. A. Cowper, Westminster; Wm. Crossley, Askham; Abraham Darby, Ebbw Vale; Joseph Dodds, M.P., Stockton; William Evans, Bradford; W. Fletcher, Workington; W. O. Foster, Stourbridge; Jeremiah Head, Middlesborough; J. J. Jenkins, Swansea; E. Jeffries, Bradford, Yorkshire; William Jenkins, Consett, Durham; Richd. Laybourne, Rhymney; S. Lloyd, Edgbaston; H. N. Maynard, Newport; R. S. Newall, Gateshead; W. G. Norris, Coalbrookdale; John Parry, Ebbw Vale; John Paton, Blaenavon; John Pattison, Newcastle-on-Tyne; J. Pearce, Newport; T. W. Plum, Shifnal; W. Price, Woolwich; Jas. Ramsden, Barrow-in-Furness; G. Ratcliffe, Crewe; J. Reed, Tredegar; E. W. Richards, Ebbw Vale; Joseph Richardson, Stockton; W. Richardson, Oldham; J. C. Ridley, Jarrow-on-Tyne; W. S. Roden, M.P., Stoke-on-Trent; B. Samuelson, M.P., Banbury; W. M. Sparrow, Wolverhampton; John Stevenson, Middlesborough; John Tate, Harrington; Thomas Udall, Silverdale; T. E Vickers, Sheffield; B. Walker, Leeds; J. Whitham, Leeds; T. Whitwell, Stockton; Townshend Wood, Swansea; E. T. Wright, Wolverhampton; the Right Hon. Levison-Gower, M.P., London.

In opening the proceedings, the noble CHAIRMAN said: As we have a programme of considerable length before us, I will not detain you with more than one or two preliminary observations in opening the business. We are met in very remarkable times, and perhaps to some of us it may almost be an effort to turn our mind from the record of sieges, battles, and surrenders with which we have been so familiar during the last four weeks. But, on the other hand, we may really look upon it as a matter of relief to be able to turn from those dismal records, and to apply ourselves practically to the matters of so much importance as are involved in the proceedings of this Institute. (Hear, hear.) As I said before, there is a long programme of business before us, and I do not think I can profitably detain you by further observations, but call upon Mr. Jones to read the report that has been prepared by the Council, and will now be presented to the general meeting. (Applause.)

The following report of the Council was read by the secretary:—

In accordance with the resolution passed at the annual meeting, approving of the publication of a quarterly journal of the Institute, in place of the Transactions, the Council have made arrangements for commencing a journal on Jan. 1, 1871. The contents of the journal will be—1. The proceedings of the Institute and of the Council from time to time.—2. The papers and discussions at the general meetings of the Institute.—3. Communications from the members upon matters of special interest to the trade which are approved by the Council. —4. A quarterly epitome of inventions, discoveries, publications, and proceedings bearing upon the British iron and steel trades.—5. A comprehensive report on matters connected with the iron and steel trades in foreign countries.

The Council have made arrangements with Mr. David Forbes, F.R.S., to act as foreign secretary to the Institute. This part of the journal will be under his special management, and the Council feel sure that it will form a very important feature in the proceedings of the Institute. They trust that the members will give the editors all the assistance they can, so that they may be able to make the journal in every way worthy of the important interests it will represent.

The Council have also been called upon to consider the necessity of suggesting the name of some gentleman as President for the next year, as the period for which the President can hold office is only two years, and as, according to the rules, a re-election cannot take place until the expiration of a certain interval. They have placed themselves in communication with Mr. Henry Bessemer, requesting him to allow his name to be put in nomination as the President elect, and they have received Mr. Bessemer's consent to such a step being taken. The Council, therefore, recommend that Mr. Bessemer should now be elected President for the year 1871.

The Sub-Committe appointed at the annual meeting to report on mechanical puddling have made some progress with their enquiry, and expect to be in a position to make a formal report at the annual meeting, to be held in the spring of 1871. They wish, however, to inform the members of the Institute that they are prepared to investigate the merits of any arrangements for mechanical puddling that may be submitted to them, and they solicit the co-operation of all members who have given any special attention to this important subject. Where any mechanical appliances have been in operation for a sufficient length of time to prove the practical usefulness of such arrangements, the committee will be glad to have an opportunity afforded them of inspecting the machines at work. They are also open to receive any communications upon the question of mechanical puddling from non-members who have given attention to this matter.

The Council have to report that the following donations have been presented to the Institute:—"Proceedings of the Royal Society;" "Proceedings of the Mechanical Engineers;" "Proceedings of the Civil Engineers;" "Transactions of the Institution of Engineers in Scotland;" "Transactions of the Cleveland Institution of Engineers;" "Proceedings of the South Wales Institute of Engineers;" "Transactions of the Institute of Naval Architects;" Jordan's "Review of the Iron Industry in 1867;" Wilkins's "History of Merthyr Tydvil."

The Council propose that the best thanks of the Institute be given to the donors for the before-mentioned publications.

The Council present the following as their retiring members for year 1871:—

Vice-Presidents: William Menelaus, Dowlais; Walter Neilson, Glasgow; J. Ramsbottom, Crewe.

Council: W. T. Crawshay, Merthyr Tydvil; Robert Cassels, Glasgow; H. O. Firmstone, Stowbridge; R. Fothergill, M.P., Aberdare; Robert Heath, Stoke-on-Trent.

With the exception of Mr. J. Ramsbottom, all the above members offer themselves for re-election.

It is competent for any member now to nominate any member for office for 1871, either as vice-president or member of council; and names can also be sent to the secretary up to within one month of the annual meeting.

The following gentlemen were also elected to membership:—Messrs. Charles Binns, Clay Cross, Chesterfield; Wm. Bragge, Atlas Iron Works, Sheffield; R. Orford Buckley, Stranton Iron Works, West Hartlepool; Thomas Carrington, Wingerworth Furnaces, Chesterfield; Samuel John Claye, Manor House Works, near Derby; James Colquhoun, Llynvi Iron Works, near Bridgend, Glamorganshire; Wm. Ferrie, Monkland Iron Works, near Glasgow; Edward K. Fisher, Market Harborough; Edwin Fox, Sheffield; Charles John Galloway, Knott Mill Iron Works, Manchester; Thomas Greenwood, Albion Works, Leeds; John Greig, Coltness, Newmains, N.B.; Sydney Hall, Swansea; Thomas Hampton, Cyclops Works, Sheffield; Edward Edwards Hewett, Don Steel Works, Sheffield; Alfred Buckingham Ibbotson, Globe Steel Works, Sheffield; Richard Machell Jacques, Easby Abbey, Richmond, Yorkshire; Benjamin Jones, Clay Lane Iron Works, Middlesborough; John Lawson, 3, Poets' Corner, Westminster, S.W.; Hon. F. E. Leveson-Gower, M.P., 14, South Audley-street, London, W.; Lewis Thomas Lewis, Aberdare; Wm. Smith Longridge, Alderwasley Iron Works, Abergate, Derbyshire; William Malcolm, Seend Furnaces, Wiltshire; F. Monks, White Cross Wire Company (Limited), Warrington; James Neilson, Mossend, Bellshill, N.B.; John H. Reed, 2, Pemberton-square, Boston, U.S.; John Rogerson, Quayside, Newcastle-on-Tyne; Francis Rummens, The Grove, Pinner, Middlesex; Thomas Southan, Muxton, near Newport, Salop; Thomas Spencer, The Grove, Ryton, Blaydon-on-Tyne; George Tosh, North Lincolnshire Iron Works, Frodlingham, Brigg; Henry Valentine Trump, Rhymney Iron Works, Tredegar; Edward Wadham, Dalton-in-Furness.

It is also reported that the proposal forms of the following gentlemen had been passed by the Council, and that they would be provisionally entitled to the privileges of members:—Messrs. Thomas Henry Anderson, Westbury Iron Works, Wilts; Charles Edward Cowper, 3, Great George-street, Westminster, S.W.; Thomas Hirst, Dowlais, Merthyr Tydvil; Charles L. Hunter, Tredegar; John Jones, Dowlais; Thomas Mason, Machen, Newport, Monmouthshire; Edward Robson, Middlesborough; E. W. Scale, Troedyrhiew House, Merthyr Tydvil; Matthew T. Show, 144, Cannon-street, London; E. F. Fox, Spring Gardens, London; F. Levick, Blaina; —Clark, Blaina; T. Hosgood, Aberdare; J. Clarke, Newton Heath, Manchester; G. H. Davey, Baglan, near Neath; C. D. Fox, London; W. Grecek, St. Petersburg.

The noble CHAIRMAN then said that if any member wished to nominate candidates for the vacancies in the Council he was requested to send in their names to the secretary. His Grace proceeded to state that he had a resolution to propose that he was sure would meet with the universal approval of the meeting. It was, "That the recommendation of the Council relative to the President-elect be approved, and that Mr. Henry Bessemer be, and hereby is, elected for the year 1871." (Applause.)——The motion was unanimously carried.

Mr. BESSEMER said the great honour conferred upon him in electing him as the future President of the Institute gave him the greatest possible pleasure. He only feared that his abilities as President, after the able manner in which the duties had been conducted by his Grace, would be felt rather among them as a loss than a gain. He could say that his best endeavours should at all times be given to his duties, and he hoped he might manage to get through them, if not to his own satisfaction, at least without injury to the interests of the Institution. (Applause.)

GEOLOGICAL FORMATION OF THE SOUTH WALES COAL BASIN.

BY MR. WILLIAM ADAMS, OF CARDIFF.

After alluding to the publications in which the geological features of this coal field have been spoken of, Mr. Adams proceeded to state that the extent of the South Wales coal field is differently estimated by various writers, but may be fairly taken to cover 937 square miles, or 600,000 acres. The total thickness of the several coal measures is roughly estimated at 60 feet, and taking this thickness, and the average weight at 80 lbs. per cubic foot, or 1550 tons per acre per foot in thickness, and deducting one-third for loss in working, faults, and waste, the total quantity of coal in the South Wales district would be 36,000 millions of tons, of which, of course, a good deal has been worked out. The coals at the eastern end of the basin are chiefly bituminous, and make a very superior coke. Between Rhymney and Dowlais a slight change takes place, the coal becoming free burning. At Cyfarthfa the anthracite appearances begin to be fairly developed, and this quality continues through the Hirwain Common across to Ynis-cedwin, in the Swansea Valley, and thence to Mynydd Mawr and the Gwendraeth. At the two latter places, perhaps, the purest quality of anthracite, except Kilgetty, is now being worked for hop and malt drying, distillery purposes, &c. The Llynvi Valley of the south crop, and westwards to Carmarthen Bay, may be considered as more or less bituminous and free burning, and Pembrokeshire as anthracite. The argillaceous iron ores are very abundant and good, and are interstratified with the coal measures, the aggregate varying from 60 to 70 inches and upwards.

Until about 30 years ago, comparatively no other iron ore was used in making foundry pig, bars, and rails. In 1836, the steam coal collieries were commenced in the Aberdare Valley by Messrs. Wayne. The demand gradually and ultimately rapidly increased, and this, with the gradually augmented make of iron, caused colliers' and ironworkers' wages to be raised in a greater ratio than the ironstone getters, and hence the production of argillaceous ironstone has decreased from 1,165,590 tons in 1865, to 628,845 tons in 1868, the deficiency for the ironworks being drawn from other British and foreign mines. Besides the argillaceous iron ores, brown hematites are worked at Pentyrch, Mwyndy, &c. These are probably of the Permian age, and are found filling hollows and fissures in the mountain limestone. The produce in 1868 was 83,835 tons. The production of pig-iron in 1827 is given at 272,000 tons; in 1839, at 435,880 tons; in 1854, at 750,000 tons; and in 1868, at 894,255 tons. The coals raised in 1854 were 8,500,000 tons; and in 1868 the quantity was 13,210,000 tons. The intersection of the coal field by deep valleys places the lowest seam within 1000 yards of the surface, so that the whole of the minerals can be won by pits of less than that depth for over two-thirds of the field—that is, between the eastern outcrop and the Vale of Neath. The dip along the north outcrop ranges from 3 to 6, and in some cases to 9 in. per yard, while on the south it varies from 9 to 12, 15, and 18 in. per yard. This gradual flattening northwards leaves a large area in the centre of the field comparatively flat. The most numerous faults run from north-west to south-east, and vary in amount of vertical displacement from 250 to 300 yards. Others running in an east and west direction have a displacement of from 400 to 500 yards. The greatest fault is one in Pembrokeshire, estimated as giving a displacement of 2000 feet. The deepest pits now sunk range from 304 to 435 yards. The paper was illustrated by a section showing the succession of measures. The top part consists of the Upper Lantwit coal, the principal seam, or Lantwit coal, being met with at a depth of 176 yards in the Taff Valley. This is a very superior coal, and the best for house and gas purposes. It is worked along the high grounds near Pontypool, Blackwood, Caerphilly, Lantwit, and Bettws.

Below these come the Pennant rocks and coals, the steam and manfacturing coals, the ironstone beds, the lower shales and Rosser veins, Farewell Rock, carboniferous limestone, and the Old Red Sandstone, which may be seen 2½ to 3 miles north of Merthyr. Westward of the Taff Valley the measures thicken considerably, and eastwards they decrease in thickness. The Old Red Sandstone composing the Brecknockshire Beacon, 10 miles north of Merthyr, is estimated to be from 8000 to 10,000 ft. in thickness, the highest ground in the coal field is the Garn Fach, a little south-west of Hirwain, is 1971 ft. above sea level. The district generally is well provided with railway accommodation, connecting it with all the Bristol Channel ports. The coal field contains some of the best beds of fire-clay known, although these are not very extensively worked. A very superior silicious fire-brick is made in the Neath Valley, and also at Hirwain. The Farewell Rock underlies the coal measures, outcropping the whole length of the field on the north and east, and on the south up to Swansea Bay, with the exception of a short distance south of Llantrissant, where it is covered over by the later-formed dolymitic conglomerate. The mountain limestone surrounds the coal field and underlies the Farewell Rock, excepting a piece near Bridgend, where it is covered by the lower Lias, and again where the igneous rocks protrude in the south-west of Pembroke. The coal measures are rich in organic remains; the flora is most abundant, and is now receiving considerable attention. The author called particular attention to the great desirability that the Government Survey should issue a new geological map of South Wales, as the present one was surveyed 30 years ago, and is, therefore, not at all sufficient for the present day, though its general accuracy is admitted.

A vote of thanks having been accorded to Mr. Adams, Mr. FOTHERGILL said he wished to ask that gentleman a question as to the remarkable change in the quality of the coal on the east of the mineral basin, as compared with that on the west—it being highly bituminous on the east, and anthracite on the west? Did Mr. Adams think the change was gradual, as in steps, at various faults? He did not know if he made himself understood. The question he put to Mr. Adams was this—The change from bituminous to anthracite, was it a gradual change from east to west, or in steps, corresponding with the faults?——Mr. ADAMS did not think the change happened through the faults—at least, not altogether.

Mr. FOTHERGILL: Or define the change? I did not assume the faults caused it. Do they define it?——Mr. ADAMS: I think not. I may be wrong; but I do not think it is caused by the faults at all.

Mr. FORBES asked whether the change in the coal was posterior or anterior to the fault—whether, in fact, the faults were subsequent to the change?——Mr. ADAMS imagined that the same causes that produced the faults must have had some effect on the coal.

Mr. FORBES remarked that if such were the case, they would expect the fault to define the change. They should have the boundaries of the change in the coal defined by the faults themselves.——Mr. ADAMS did not see that that was necessarily so.——Mr. FLETCHER wished to know if any seams of coal existed under the limestone?——Mr. ADAMS: I do not know of any.

Mr. FLETCHER: Or does the Permian sandstone overlie any of the coal?——Mr. ADAMS said that was so, as to a small portion west of Llantrissant. But it only covered small seams in a small crop.

Mr. FOTHERGILL observed that, touching the subject he had raised, he had some special information, which showed that the changes occurred in steps. In the Aberdare Mountain there was a fault of 80 yards. The coal up to that point was of one quality, and beyond that it changed, which made him suspect that it was constantly changing.

The discussion shortly afterwards dropped.

ON PUMPING AND WINDING MACHINERY.

BY MR. G. C. PEARCE, CYFARTHFA IRON WORKS.

The author, in this short paper, gave a description of pumping and winding machinery at a pit belonging to Mr. R. T. Crawshay, named the Castle Pit, and situated near to Merthyr Tydvil. The piston of the pumping-engine is connected with the pump rod, so as to work direct. The beam is placed below the cylinder, and the motion is regulated by means of a crank and fly-wheel. The pump-rods are raised by the piston, but they perform the down-stroke by their own weight, which is considerably more than the water-load, the excess of weight being balanced as much as necessary by making the crank end of the beam much heavier than the pump end, and by using a heavy connecting rod. The stroke at the pump end is 8 ft., but at the crank the stroke is 13 ft. 4 in., which gives the crank end considerable leverage, and helps to balance. The pit was sunk in a stone quarry, and it was necessary to raise the top of it up to the level of a railway by building masonry, so the beam was placed below the cylinder, to make this masonry also form the engine-house. The nozzle is furnished with a steam-valve and discharge-valve, opening into and out of the bottom of the cylinder. They are worked by two separate eccentrics, so that the steam-valve can be made to cut off the steam at any part of the stroke required. The nozzle is arranged to admit the waste steam to the top of the cylinder during the down stroke, to keep it hot. There are two valves in addition to the working valves, moved by screw handles, to shut off the supply of steam and to regulate the discharge. All these valves are "double beats." The diameter of the piston is 68 in., and the pressure of steam in the boilers is 40 lbs. per square inch. The rim of the fly-wheel is 26 ft. diameter over, and weighs 37 tons. The pit is 333 yards deep to the bottom of the sump, but the pumps only raise the water 279 yards, where there is an adit. There are four lifts, and all the pumps are forcers, with plungers 15 in. diameter; but the lower forcer has an extra valve-box and working-barrel, 14 in. diameter, fixed upon it, so that, in case of accident, a bucket can be put to work in the lower column, thus turning it into a temporary lifting pump. The valves used in these pumps are common lifting-valves, made of gun metal. The pump-rods are wrought-iron bolts, 18 ft. long, each rod having a socket at the end to receive the next rod below it, and they are fastened together by cotters passing through them in the usual way. The diameter of the rod at the top is 6¾ in., but the section is lessened as the tension decreases, till the bottom rod is only 4½ in. As it is necessary to place the plungers close to the main pump-rod, to make the set-off as short as possible, there is no room for cisterns, so the water is delivered from one pump to the next by means of lodge rooms formed in the side of the pit. The shape of the pit is oval, 22 ft. 8 in. long by 12 ft. wide, with a brattice dividing the winding parts from the pumps. A space is left vacant between the brattice and pumps, large enough to repair or change any part of the pump work without interfering with the winding. The guides used for the cages are rails in 18 ft. lengths, fastened by means of chairs to oak stemples every 9 ft. The winding-engine has cylinders 36 in. diameter, and 4 ft. 6 in. stroke, worked by steam at 45 lbs. per square inch. The piston-rods are guided by parallel motions, and the valves are worked by slot links, the valves being "double beats." There are safety-valves fixed on the cylinders to prevent over-straining, and the drums are furnished with a steam brake. The drums are 12 ft. diameter at the centre piece, and 16 ft. 6 in. over the rim, and flat-ropes are used. The cages are made double, to lift two trams at once, each tram of coal weighing 31 cwts. long weight.

A vote of thanks was accorded to Mr. PEARCE for his paper.

Mr. COWPER offered some observations in reference to the working of steam for pumping, winding, and blowing-engines. In practice they commonly found it the case that gentlemen did not care for a large amount of expansion in one cylinder, on account of the irregularity of motion. He had endeavoured to expand steam eleven times in one cylinder, but he found it most unsatisfactory, because it inevitably induced great irregularity of motion. In practice, this great expansion in one cylinder was not used except in the Cornish engines, where there were no parts to jar—no fly-wheel or crank. The speaker then, at great length, proceeded to enter into details, but it would be useless to follow these in the absence of the elaborate plans by which they were illustrated. He took two cylinders, and cut off the steam at half stroke in the high-pressure cylinder. The steam then passed into the reservoir, where it was kept warm, and taken care of until the cranks had moved 90 degrees, the steam then passed into the low-pressure cylinder. So that there were two figures—one high-pressure and one low-pressure, and the expansion was from half stroke. He had not followed the truly theoretical curve of the steam. But when the steam came out of the high-pressure cylinder, they had a portion of isolated steam warmed up, which was an easy method to obtain a greater degree of economy than the true theoretical curve. As to the results, he might state that they had had three pumping-engines, and more were being made. They had also one marine engine for Her Majesty's ship Briton, which was 2146 horse-power; and steaming at her fullest steam, at the measured mile, she made 13¼ knots, with 1·98 lbs. of coal per horse-power per hour. When working easier, at 10 knots an hour speed, she burnt 1·3 lbs. coal per horse-power per hour. If the proof of the pudding was in the eating, these engines certainly worked with more economy than most engines. But it was a satisfactory solution to find that they had a fair engine with one cylinder on each crank, and the cranks at right angles.

ON THE CONDITION OF CARBON AND SILICON IN IRON AND STEEL.

BY GEORGE J. SNELUS, ASS.R.S.M.

This was an elaborate paper, giving the details of experiments for ascertaining the condition of carbon and silicon in iron and steel. The powerful influence of these substances is admitted, and it is generally allowed that carbon may exist either diffused through the mass as graphite or in some form of combination with the iron. He points out the desirability of more workers in this field of research. He gives evidence to prove that carbon is only mechanically combined with cast-iron, and expresses his belief that there is no definite chemical compound of iron and carbon, but that the absorption of carbon by iron is a case of chemical solution, and he supported this statement by reference to the phenomenon of solution in general. The effect of silicon upon iron and steel is to render it hard and brittle, and in all probability the reason why Fairbairn and others have found pig-iron to increase in strength by several successive meltings is that by these fusions more or less of the silicon is removed. While melting, however, the iron gradually takes up sulphur and phosphorus from the fuel, and, in the end, the deterioration due to these substances more than counterbalances the increased strength caused by reduction of the silicon. He states that scales of graphite can be removed from compact grey iron, and that these scales consist of pure carbon, for he considers it morally certain that the traces of iron found with them were simply accidental, and in no way combined with the carbon.

The largest amounts of graphitic carbon are contained in grey Bessemer pig, and of combined carbon in spiegeleisen, this alloy of iron and manganese having the property of retaining carbon in "combination" to a greater extent than iron alone. Some old analyses have been published, in which the total carbon in different classes of iron is shown as high as 6 per cent.; but in some hundreds of analyses of all brands of iron that have been made by the author he has never, in a single case, found the carbon to reach 5 per cent., and this he thinks will be corroborated by all who have made analyses with our modern improved means of research.

From the experiments of Mr. I. L. Bell, it would appear that some of this carbon is taken up by the ore during the process of reduction; but it is commonly supposed that the greater portion is taken up after complete reduction, and that the great cause leading to high carbon in pig-iron is long contact of the fused metal at a high temperature in contact with carbon. The nature of the slag has an important effect in determining the quantity of carbon, which appears to reach its maximum when the blast is hottest, slag most basic, ores least silicious, and burden light.

Silicon oxidises more rapidly than carbon, but when the percentage of the latter is exceptionally small it sometimes, though not often, happens that the workmen are deceived, through the whole of the carbon being oxidised before all the silicon is removed. There does appear to be some difference in the modes of existence of sulphur and phosphorus in pig-iron, for in completing the analyses of the various products obtained by mechanical separation, as explained above, the author was struck with the remarkable and unexpected fact that the finer portions, which contained most graphite, contained also an increased per cent. of sulphur, while the phosphorus decreased in about the same ratio as the iron. The manganese also appears to accompany the sulphur to some extent.

In concluding his paper, Mr. Snelus records his appreciation of the eminent services rendered him by his assistant, Mr. W. Jenkins.

The noble CHAIRMAN said they would all be rejoiced to accord the thanks of the meeting to Mr. Snelus for his valuable paper. (Applause.)

Mr. I. LOWTHIAN BELL, after referring to the paper just read as a strong proof of the sagacity of the decision of the Council to circulate printed copies of the papers read before being discussed, expressed coincidence in the view that Dr. Percy had made a mistake in asserting that a grain of graphite could not be taken on the point of a penknife. With regard to the very important object alluded to by Mr. Snelus—to introduce the suggestion, the offer of which, he was glad to see, was so promptly received—that they should have a chemical laboratory in connection with the Institute, he apprehended that there would be more difficulty in carrying that out than Mr. Snelus anticipated. If he gladly heard the applause with which the suggestion was made it was because he inferred from it that the ironmakers of this kingdom were willing to ask for that assistance which science could alone afford, rather than from a sanguine belief that a laboratory in connection with an institute like theirs could be carried into practical effect. Mr. Snelus had referred to some of his (the speaker's) own labours in connection with the deposit of carbon. Now, he had guarded himself sufficiently, he hoped, from the suspicion that he had made any positive assertion that at low temperature, or while iron was in a partially reduced state, carbon had absolutely entered into combination with the iron. All he had pretended to point out was that the carbon was a deposit by decomposition or dissociation of carbonic oxide into the interstices of the iron ore. And that it was this (almost irrespective of the reduction of the ore itself) he had had abundant opportunities since he had made his first communication to the Institute of proving. He did not mean to say that a certain amount of reduction in the first instance was not required, but that it depended in the result on the quantity of carbon deposited—of that he was certain. Within the last week he precipitated on iron 300 per cent.—that was, three times the weight of carbon upon iron, actually into the ore, while there was only the 3 per cent. of oxygen in the ore removed; indeed, he had found this—with the lesser removal of oxygen, great deposition of carbon. All he wished to show was that the dissociation of carbonic oxide took place at a low temperature. No apology was needed from Mr. Snelus for bringing the matter forward. Much the same observation was applicable to silica, and in his own experience he had had the opportunity of observing something that bore on Mr. Snelus's paper. Mr. Snelus told them—"The balance of evidence, then, appears to favour the theory that silicon is dissolved, or (to borrow a word which perhaps more nearly impresses the state of combination) 'occluded' in the iron in the same way as the carbon, but that the solvent power of the metal is so much greater for silicon than for carbon that it is quite a rare thing, even if it ever occurs, for silicon ever to separate in a free state from the iron." He could not remember the exact analysis, but he remarked again that in pig-iron hot from the blast-furnace, in particular kinds of ore, as iron ore, they had found it rich in silica. That there had been a coating in some instances of ¼ in. of a deposit of fibrous silica, in such fine divisions, and under such circumstances, he could not doubt. It might have proceeded from occluded silicon of pig-iron being forced out during the process of cooling the pig-iron, and as it came into contact with the air becoming oxidised and being converted into silica. The fact was that a quantity of silica was formed under the conditions just mentioned. That it was a rare occurrence he was willing to admit, for in 25 years' experience in the manufacture of pig-iron he did not remember noticing the circumstance more than three or four times. With regard to silicon delaying the process of puddling, that he believed was an established fact. Indeed, under some circumstances, where the silicon amounted to something like 7 per cent. of the weight of iron, it seemed almost impossible either to puddle or refine it. He remembered receiving from Scotland a quantity of iron—glazed pig-iron—and neither in the refining blast nor in the heat of the puddling-furnace could they reduce it to iron. It was only by adding infinitesimal pieces of other iron that they could get rid of it.

Mr. BESSEMER wished to make a remark on the presence of silicon in steel. A very general opinion prevailed in the trade (and it was correct when they spoke of large quantities) that silicon was deleterious to the make of iron. It was the impression that they should get rid of silicon, and they would then make better iron. That was not the case, in proof of which assertion he called attention to the old steel process, as carried on in Sheffield, and adduced instances to show that the presence of silicon improved the quality of the manufacture. He had not had an analysis of the best quality of Sheffield steel that did not contain silicon.

Mr. SNELUS said he wished to make one or two remarks in answer to Mr. Bell, with regard to his observation on the deposition of carbon in the ore. During the process of reduction he had made a few experiments in that direction, and he thought the position of carbon in the ore during the process of reduction was due more to the action of fine particles upon the gas at high temperature. For this reason he had taken pure sand, although he had in this case taken coal gas, and the conditions were rather different from those of Mr. Bessemer. But he had taken fine angular particles of sand, and heated them in a tube, through which he passed coal gas, and on the angular particles carbon was deposited, which was not deposited on the porcelain tubes in a combined substance. So that he thought the deposition of carbon in the ore was due to other than the chemical manner of reducing the iron. He found, as Mr. Ball had said, that reduced ore combined more or less of carbonaceous matter, but it was not in a state of chemical combination. For instance, if they attempted to dissolve reduced iron, and he had perfectly reduced some in that condition, they did not get the colour. Many of them were familiar with the "iron test," that the remaining carbon was not soluble. Egert's process showed that the carbon in reduced iron rusted from some other condition than that it was not soluble. It was left as free carbon, and not combined carbon. He had not a word to say as to Mr. Bessemer's remarks, except as to his own experience that he had never found an instance, as stated in the paper, where the finest qualities of iron and steel were perfectly free from silicon. There was an example in their own Bessemer steel, which contained 00·9 per cent., and which, in fact, was so small that they were scarcely able to estimate it. But they did estimate it, and there was actually that quantity; and he had never found a case in which, in dissolving iron or steel in a large quantity, they did not see silicon. With respect to the separation of free silica from iron, the instance given by Mr. Bell showed that his were most exceptional circumstances. He was not sure that it was separated from the pig-iron as silica, or whether the form in which Mr. Bell found it was not due to other causes. It was well known that free silica was found in blast-furnaces frequently, and that was pointed out to us as a proof that it existed in the pig-iron in a free state. But he did not see the connection, because he thought silica might be found in a free state in blast-furnaces without going into the composition of the pig-iron.

A METHOD OF DESIGNING RAILS.

The discussion of the paper on this subject, written by Mr. THOMAS GILLOTT, Nomanton, and read at the May meeting, was then taken.

Mr. SANDBERG said that the interests of railway engineers and rail makers were identical, though what he might state might be more pleasing to railway engineers than rail makers. At the same time he was glad to see his sections had had some success, in the fact that they had been adopted by railway engineers; and although they might not now be so favourably viewed by rail makers, he hoped no more difficulty might be experienced with them than with others. So far as he could ascertain there was only some slight objection, resulting in a trifling extra price

over that of the ordinary section. As to Mr. Gillott's paper, he had information from him that he did not intend to define the sections, but to afford rules to proportionate sections to different weights. Assuming this or that section, Mr. Gillott told them how to increase or diminish it to any given weight. He (the speaker) was willing to admit that his sections were not what rail makers would wish, but he believed that rail makers might have much greater quantities to deal with, and they would not be unreasonable. He took the opportunity of calling attention to the fact that there was a remarkable increase in light rails in Russia, India, Sweden, and Norway; and he believed that in a few years there would be a great increase and revival in that trade. He also pointed out the necessity for rail makers to meet the demand. Last summer he had had considerable orders, and he had had some difficulty in getting them executed, because the mills generally were so large that makers preferred 50 or 60 lbs. rails; but for his purpose he required a 35 lb. rail; and if, as seemed probable, small traffic railways came more into operation, there would be considerably increased demand for light rails. He believed the section for light railways adopted in Norway and Russia would be found to become much more a standard section.

Mr. FOTHERGILL thought that Mr. Sandberg's remarks—and Mr. Sandberg had had much experience—were greatly to the point as to light rails. There was certainly considerable demand for light rails in the countries where the traffic was small, and the rails had to be slight. For many years he had thought that heavy railways and rails could not be afforded. They were very fortunate, indeed, in having present an eminent engineer, Mr. Fox, who had given much attention to the subject of bringing useful light rails into use. If the Institute thought well, he would urg Mr. Fox to give them some information on the subject. His (Mr. Fothergill's) object in rising, was to tell his friends and the meeting that at Plymouth they had two mills for making light rails, 40 lbs. to the yard, made on the system calculated to produce a good quality of any rail, and particularly a light rail. He invited gentlemen present who took an interest in the subject to go to Plymouth and see the light rails made, and they would probably have an opportunity of seeing the rails fractured and tested; and, in fact, see all that was to be seen. It was a subject that interested them all very much.

Mr. DOUGLAS FOX said it had not been his intention to say anything on the subject of light rails, but having been called upon, he had much pleasure in stating that for some 12 years their attention was called to the absolute necessity of reducing the cost of railways in the colonies, and other countries where the traffic was small. To do that they thought it necessary to lay down two principles—first of all, the rolling load they had to accommodate; and, secondly, the maximum speed the trains had to run. After extreme consideration and consultation with a most able engineer in Norway, Mr. Peel, they came to the conclusion that for ordinary purposes in the colonies it would be ample if they provided for a rolling load of 4 tons by any wheels pressing on the rails—at a speed of 20 to 25 miles an hour—20 miles, including stoppages. They came to the conclusion that they could provide amply for the necessity of that traffic by a rail varying from 30 lbs. for the level line to 40 lbs. on inclines, and where the curves were severe. He could judge the results of the light rails on main lines, especially in Australia and India, and they had the experience of Mr. Peel in Norway, and an equally eminent engineer in Sweden. They found that with these rails, well laid, and properly fished, carefully secured and joined—all matters of great importance—the results were in the highest degree satisfactory. He had rails in India 32 lbs. to the yard, which had been down five to six years, and had never had a rail replaced. He did not propose a 40-lb. rail for the heavy traffic on the main lines in England, their object had been to provide for the necessity of light lines of traffic. They were now making, as Mr. Fothergill had just stated, rails for Canada, weighing 40 lbs. to the yard, and they would have the opportunity of seeing the strength of those rails when properly constructed. If they had 8 tons of wheel falling on a rail of 70 to 80 lbs. to the yard, they found a 40-lb. rail was equally good for a 4-ton weight. The whole expense of providing these railways, including rolling-stock, station accommodation, and every other requisite, was about 2900*l.* per mile, and the Canadians were now constructing their own railways complete, with rolling-stock and managing expenses, for under 3000*l.* a mile.

In reply to Mr. Talbot, Mr. FOX standard length of the light rail was 24 feet, the distances between the centre of the sleepers 2 ft. 6 in.

On Tuesday afternoon the members visited the iron works belonging to the Plymouth Iron Company, near Merthyr. The party, numbering about 200 gentlemen, were conveyed by special train shortly after 1 o'clock. After inspecting the Plymouth, Pentrebach, and Duffryn Works, where pig-iron, rails, and merchant iron are produced, the members had next an opportunity of seeing in operation the pumping and winding machinery described in the morning by Mr. G. C. Pearce. The Castle Pit is the property of Mr. Crawshay, and the arrangements for pumping and winding were much admired by the members. Another special train took the party to the Cyfarthfa Iron Works of Mr. Crawshay. These extensive works are universally admitted to be about the most orderly and well-arranged iron works in the country, every part showing that the greatest care is taken in carrying on all parts of the iron manufacture. The blast-furnaces—11 in number—are in a long line, and the pig-beds are all roofed in. The rolling-mills are chiefly devoted to the manufacture of rails. One characteristic of Cyfarthfa is the immense quantity of puddled-iron usually kept in stock by the firm. At present there are upwards of 20,000 tons of puddled-iron stacked in "houses," each containing 300 tons. The members returned to Merthyr about 6 o'clock in the evening.

WEDNESDAY.

The members re-assembled under the presidency of the Duke of Devonshire, the attendance being still further increased.

ON PYROMETERS.

BY MR. C. W. SIEMENS, F.R.S., D.C.L.

The author stated that, though many attempts had been made to produce a reliable pyrometer, it could hardly be said that such an instrument is in the hands of the practical metallurgist. The Wedgewood pyrometer was the first noticed. This instrument is liable to error, because a shrinkage of the fire-clay ball is caused by the expulsion of water of hydration, which must necessarily take place, chiefly at one particular temperature. This is proved by the discordant, and, in fact, impossible results recorded in chemical works as being obtained by means of this instrument. The air pyrometer of Mr. Gauntlett was noticed in the second place, but the author considered that this cannot be relied upon beyond a point approaching red heat, at which a permanent elongation of metals, exposed to heat, sets in. The third pyrometer noticed was the one constructed by Mr. Siemens, based upon the supposition that the specific heat of metals is the same at various temperatures, and that by measuring the heat of the ball of metal, after it has been exposed to the heat to be estimated, a true measure of its intensity is obtained. This instrument consists of a portable vessel, composed of three concentric cylindrical vessels of thin copper-plate, the two interstine spaces being filled with non-conductors of heat. A delicate mercury thermometer is fixed in the interior of the vessel, and this thermometer is furnished with a movable sliding scale, showing pyrometer degrees, of which one is equal to 50 ordinary degrees. The instrument is accompanied by balls of platinum or copper, which are so adjusted that 50 of them would be equal in thermal capacity to an imperial pint of water. Immediately before using the instrument an imperial pint of water is poured into it, and the pyrometer slide is so moved that its zero point coincides with the top of the mercury column in the thermometer tube. The ball is thereupon exposed to the heat for two or three minutes, and then plunged into water. The mercury will be observed to rise, and the absolute temperature of the place measured is ascertained by adding the reading on the pyrometer scale, opposite the new level of the mercury, to the degrees of temperature indicated by the thermometer before the ball was introduced. The author has recently devised a pyrometer of a more universal applicability. It is based upon the properties of the pure metals to offer an increasing resistance to the passage of an electrical current with increase of temperature. A platinum wire of known electrical resistance is wound upon a cylinder of fire-clay, upon which a helical path has previously been cut to prevent contact between the turns of the wire. The coil of wires, so prepared, is enclosed within a cylindrical casing of platinum, if the temperatures to be measured exceed the welding heat; or of iron or copper, if lower temperature only requires to be measured. The two ends of the coil of wire are brought out endways, and are attached within the protecting tube to thicker leading wires of copper, insulated for a short distance by being passed through pipe-clay tubes, and further on by India rubber, or gutta percha, terminating at the measuring instrument, which may be placed at any convenient distance. This latter is of peculiar construction, its characteristic feature being that the usual calculations necessary in determining electrical resistances by the Wheatstone or other methods are dispensed with, and a reading in degrees of a large scale is at once obtained by so placing the index lever that the electrical current, generated in a small battery and passed through the measuring instrument, including the platinum wire of the pyrometer, produces no deflection of the galvanometer needle. These degrees do not express the temperature, but the temperature they represent is expressed by the accompanying table of reference, which has to accompany each instrument. The correctness of this instrument depends solely on the ratio of increase of electrical resistance in the platinum wire, with increase of temperature. This rise is considerable, the resistance being increased fourfold by an increase of temperature from the freezing point to about 3000° Fahr. The ratio of increase is, however, not uniform, but follows a parabolic law, which the author has embodied in a table. The pyrometer last described is the result of much careful investigation on the part of Mr. Siemens, who has been animated by a desire to fill up a blank in the means at our disposal to carry on metallurgical enquiries with a high degree of certainty, and he, therefore, does not seek any commercial compensation, through the Patent Office or otherwise, for using this invention.

Mr. SIEMENS, having supplemented the reading of his paper by some observations further illustrating by models the operations of the pyrometer,

Mr. SNELUS put several questions, in reply to which,

Mr. SIEMENS said, with regard to the first question, whether any permanent change occurred in the resistance of the wire through exposure to heat, he had found that such was not the case. The wires, no doubt, elongated slowly when exposed to heat frequently; but with it the lateral dimensions also increased. They did not deal with the length only, but the total capacity to conduct the electric current. With regard to the second question, as to the cylinder of fire clay, he found from experience that the conductivity had risen with the temperature. As to the third question, the method of checking the instrument after it had been in use for some time, that could only be done in practice. It would be a desirable thing to do, but from the trials made he found there was a guarantee of certainty, for if the wire were to break, the instrument would cease to work at all; and in electrical experiments generally the faults, if they occurred, were of a very perceptible and decided nature. Of course the instrument would be destroyed if exposed to intense heat, but he thought they had a guarantee in the instrument that it would tell its own tale.

Mr. BELL enquired the cost of the instrument?—Mr. SIEMENS said that it was difficult to say, and he explained that it might be 16*l.*, or it might be 10*l.* But if the tube when of iron or platinum, such as would suffice for a temperature below welding point, the cost of that part of the instrument would be trifling.

Mr. BELL wished to say a few words upon the paper just read. All who had attended at all to the preparation and consumption, if he might so called it, of heat in the blast-furnaces, could not be sufficiently grateful to anyone who came forward and presented them with a reliable instrument, capable of giving a proper record of heat at high temperature. After some very practical remarks, the speaker expressed a hope that Mr. Siemens' invention would in its working answer all the expectations he had formed.

Mr. COWPER thought Mr. Siemens had scarcely done himself justice with regard to the certainty with which the apparatus worked; and he gave an illustration of the admirable operation of a pyrometer of Mr. Siemens' invention for testing (at any part) the temperature in a coil of telegraph coil, a thousand miles long, which was stowed in the hold of a ship.

This closed the discussion, and a vote of thanks was accorded to Mr. Siemens.

THE EFFICIENCY AND DURABILITY OF PLAIN CYLINDRICAL BOILERS.

BY MR. JEREMIAH HEAD, MIDDLESBOROUGH.

The writer states that his object is to call attention to many high qualities possessed by the plain cylindrical type of boiler, qualities which are, however, counterbalanced by certain serious defects. He proposes to investigate the cause and extent of these defects, and to point out satisfactory remedies. Anticipating the objections of those who are likely to urge that plain cylindrical boilers are wrong in principle, and ought to be entirely superseded, he submits that new enterprises, under the most unexceptional management, still continue to be furnished with these, in preference to other kinds of boilers, and were this not the case, the number in use is sufficient to give importance to any plan whereby greater efficiency and durability are likely to be secured. Out of 17,825 boilers now on the books of the various insurance companies 4052, or 22·7 per cent. of the whole, belong to the class referred to. They are, however, differently regarded in different districts, the proportion varying from 12½ per cent., as reported by the Manchester Steam-Users' Association, to 69 per cent., as returned by the northern district of the Midland Steam-Boiler Inspection and Insurance Company. The writer next describes and illustrates the details and arrangements connected with an ordinary plain cylindrical boiler, dwelling upon their simplicity, ease of examination and repair, and small first cost. Excluding brickwork and fittings not rivetted to the boiler, a 50-horse power boiler, or one capable of evaporating 50 cubic feet of boiling water per hour, would cost, according to present market price, about 100*l.* To accomplish the same duty, an internally-fired boiler would cost nearly three times that amount, and the saving of fuel effected by it would only be about 9 per cent. He, therefore, asks how it is that many are prepared to adopt the more complex appliance, at nearly three times the outlay, unless there is some further reason for such preference? The reply to this question may be expressed in homely language in very few words. Plain cylindrical boilers are liable to break their backs. The manner in which the serious fractures so described destroy the structure is next illustrated. They do not occur in the region of the most severe heat, but, on the contrary, where the plates are unscaled and retain their original appearance. They can only be due to heavy tensile strains. The writer has often observed that the ends of boilers are apt to lift themselves up clear of their supports, leaving the whole weight—say, including water, 16 tons—upon one bearer alone. This happens when the boiler is at work, and is owing to the superior heat and greater expansion of the bottom of the boiler as compared with the top. On withdrawal of the fire and release of the steam the boiler ends were observed to return to their bearings, and the centre to show an inclination to arch itself up clear of its support. In the former case the bottom of the boiler must have been subject to severe compression, and in the latter to tension. The ultimate result of such a state of things could not be other than fracture across the weakest seam. The average difference of temperature between the top and the bottom of externally-fired boilers is next estimated, and the difference in expansion computed. A boiler 45 ft. long when at work constantly endeavours to lift its ends something like 3 inches. By reason of its own weight, that of the water within, and the rigidity of the structure, it is prevented from changing its form to that extent. It is, therefore, only by compression of the bottom plates and exclusion of the top that the forces brought into play can be absorbed. So much for expansion of the bottom when the boiler is at work. But what takes place when it becomes cool? Has it become permanently elongated? Does it return exactly to its original length? Or is it permanently contracted? If the latter—that is, iron heated and cooled in contact with water—contracts every time the operation is repeated, then at the end of every week the bottom of a boiler must evidently become shorter, and the whole structure must ultimately either arch itself up clear of the middle supports, or must break across the bottom. To satisfy himself respecting the behaviour of iron under these circumstances, the writer made a series of experiments upon strips of boiler-plate, fitted to a gauge exactly 1 ft. in length. These strips were carefully heated to a temperature of about 890°, and then slacked in boiling water. This was intended to imitate the condition of the bottom of a boiler at work and off work, as at the end of a week. One strip was so heated and cooled 20 times, a second 40, a third 60, a fourth 80, and a fifth 100 times. The result evinced a small but steady permanent contraction, amounting in the last case to 1-14th of an inch. The writer contends that these facts entirely account for the fracture of boilers as described, and that the same fate must eventually befall all which are externally fired, provided they are so set as to be unable readily to assume new forms. He next submits his plan for removing the evil, which is to substitute yielding for rigid supports. He recommends that boilers should be hung upon evolute springs, and illustrates how this may most readily be done. The alteration and expense entailed appear to be but slight. Besides the lengthening of the suspension rods, and the introduction of the evolute springs, the connections between each boiler and the general mains must be made circuitous instead of direct, in order to avoid risk of breakage from too much rigidity, and appliances called gags are made use of in order to prevent too much rise and possible disturbance of brickwork when the water is released. This is all that is necessary to produce the desired effect. A boiler so altered has been at work at Middlesborough since the beginning of March. The lifting at the end supports, which are 19 ft. each from the centre, is found to be ⅜ inch. The best way to support boilers of various lengths is next considered exhaustively, and the methods recommended are set forth in a number of illustrations. The amount of lifting at any point is shown to increase as the square of the distance from the centre. No springs are necessary for boilers 30 ft. in length upon two supports, but for lengths of 60 to 75 ft. five supports are required, the end ones being furnished with double springs. Lest any should still be found to doubt the seriousness of the evils treated of by the writer, he concludes by quoting the experience of several engineers of boiler insurance companies and others whom he has consulted while his paper was in course of preparation. The general tenor of their observations seems to confirm the writer's views as to the magnitude of the evil, but betrays a great want of unanimity as to probable causes and appropriate remedies.

Mr. LONGRIDGE criticised the cost of the respective boilers, contending that the price of the Lancashire boiler was put at too high a figure. He also questioned the correctness of the figures as to the evaporation, which he held to be, in experience, favourable to the Lancashire boiler. Likewise he disputed the assumption that the plain cylindrical boiler was safer than the Lancashire boiler; and in an elaborate speech replied diffusely to many of the arguments and statements of the writer of the paper.

Mr. BAGNALL, M.E., detailed his experience, and the degree to which he had suffered. He said they had taken off the domes attached to the boilers, and taken the steam over the centre, and since that time they never had a boiler crack. The rise and fall had continued at both ends, but they had had no cracking. It was curious that the rising and falling continued during the continuance of a dry season. The boiler might be working badly in that respect, but a storm of rain, or a change of weather, brought them down again.

Mr. SIEMENS thought it important that they should know whether the bars experimented upon were cut longitudinally with the grain, or across the grain.

Other members concurred, and Mr. WILLIAMS said he had many years made experiments dealing with the question of the contraction and expansion of iron with repeated heatings, and the conclusion he had come to was that taking a flat bar, rolling it, and heating it so protected it, it could not be oxidised, the iron contracted enough came to the same length, and, that being done effectually once, they might repeatedly heat the iron without any such further alteration as Mr. Williams had described.

Several gentlemen having spoken at some length,

Mr. FOTHERGILL said he wished to know what kind of boiler Mr. Head recommended, as he hardly understood that point. As to cost, he had not found much difference between cylindrical and tubular boilers.

Mr. T. Whitwell, Mr. Adamson, and Mr. Richardson then dwelt upon the merits of the respective boilers, after which

Mr. HEAD replied on the whole discussion. In comparing the cost, which was a difficult thing to do, he took the method he thought best. At the time he referred to there was a large order given out in the Middlesborough district for boilers of the kind. They were specified to be at the rate of 18*l.* 10*s.* per ton. With regard to double-flue Lancashire boilers, an order had been given to Mr. Adamson himself at 27*l.* 10*s.* per ton. As to the evaporation, his experiments had extended over 130 hours, with best Durham coal; the measure had been taken by Siemens' water-meter, and tested by Kennedy's cylinder. With regard to safety, he had said that so far as they had gone already the boilers were apparently safe. He admitted that the breaking of the back made them less safe, but that he hoped to obviate. Gentlemen, while admitting that the boiler did lift at both ends, seemed to think that no harm would result. But it was horrible to contemplate a boiler 45 or 60 ft. long supported in one point at the middle, the great weight at the two end supported on that one point, or supported at the two ends, and nothing in the middle. He did not know how the owners of boilers could be comfortable when their boilers were undergoing that state of things. Mr. Compton had spoken of carrying the heat over the boiler, and if that could conveniently be done it would lessen the evil to a great extent. After replying to Mr. Williams, Mr. Jones, and other members, Mr. Head, in answer to Mr. Fothergill, as to which boiler he thought best, said his object had not been to become a partizan, but to hear what could be said for and against the boilers respectively.

The discussion then closed, with thanks to the writer of the paper.

There was not time to read Mr. Robin's paper, which was taken as read, to be discussed at the next meeting.

PRODUCTION OF ALLOYS OF IRON AND MANGANESE.

THEIR APPLICATION TO THE MANUFACTURE OF STEEL.

BY MR. E. KOHN, C.E., LONDON.

The author stated that the properties of the alloys of iron and manganese have not, as yet, been completely investigated, and much difference of opinion exists with regard to the theoretical position of manganese in the process of steel manufacture, though absolute unanimity prevails amongst steel makers as to the practical necessity of employing manganese in the manufacture of cast-steel. The reduction of pure manganese from its ores, or the production of pure carburet of manganese, present considerable difficulties, and therefore, the production of metallic manganese has never been successfully carried out in commercial practice. The principal supply of metallic manganese for the modern steel manufacture is obtained in the form of alloys of iron and manganese, produced by a variety of processes, and differing in their nature and qualities to a considerable extent. Alloys of iron and manganese are reduced from natural or artificial mixtures of the ores of both metals with all the greater facility the higher the proportion of iron and the smaller the percentage of manganese is required for the product. A speciality of such pig-iron which contains a proportion of from 7 to 11 per cent. of manganese is the well-known spiegeleisen from the district of Siegen, in Rhenish Prussia. This pig-iron is made from a spathic iron ore, which is a crystallised compound of carbonate of iron and carbonate of manganese, and which occurs in a large vein in a mountain called the "steel mountain," at Müsen. The production of spiegeleisen, however, requires a particular management of the furnace; it is necessary to protect as far as possible that part of the smelting process which is destined to the carburisation of the reduced metals, and for this reason the charges must be so managed that the ores are quickly reduced, but a long time is afforded to the reduced spongy metal before actual fusion takes place. The iron must be carburised at a temperature which is not sufficiently high for the reduction of silicon from the slag, yet, at the same time, the temperature at which manganese is reduced from its ore is nearly as high as that which will allow the silicon to pass into the metal. The presence of a considerable percentage of silicon, however, would prevent the production of specular iron, since the presence of silicon in molten iron has a tendency to drive the carbon out of its state of combination, and change it into graphite. The iron, instead of being specular, would become grey or mottled according to the temperature of the furnace, and its properties would be different from those of the spiegeleisen proper. On the other hand, if the temperature of the furnace is too low, or the time required for the carburisation is too short, common white iron will be produced, containing only a small proportion of combined carbon, and very little manganese.

The principal art in making spiegeleisen consisted formerly in making the ore capable of quick reduction by calcination, using burnt lime and only a small quantity of clay-slate as flux, in order to reach the stage of carburisation as quickly as possible, and applying cold-blast and charcoal, in order to keep down temperature of the zone of fusion, and thereby protract the preceding stage to the utmost extent possible. With recent improvements, and the necessity for economy, the ironmasters of Siegen have learnt to make spiegeleisen with hot-blast and coke, with utilisation of waste gases, and a high temperature in the zone of fusion. This is done principally by keeping out the silicon with an overdose of burnt lime, which also assist in preventing the sulphur from the coke from acting injuriously upon the iron. With all these precautions, however, it is not possible to produce spiegeleisen at all times and continuously in the same furnace. Fluctuation in the temperature and pressure of blast, and similar apparently very slight causes, will suddenly change the produce from spiegeleisen into grey or mottled iron, if the heat is excessive, or the slag too rich in silica, or the coke too much contaminated with sulphur; or common white iron will be produced if the temperature gets too low, or the burden too heavy. With the best managed blast-furnaces, intended specially for making spiegeleisen, only 70 to 80 per cent. of the total annual produce is iron of that class, the remainder being either grey or white, according to the side to which there is a greater liability of error in the particular furnace. The proportion of manganese in the spiegeleisen from the Siegen districts rarely exceeds 10 per cent., and the average percentage of manganese in this material is about 7 per cent. The quantity of combined carbon in the spiegeleisen is almost constant, and amounts to 5 per cent. In adding a dose of spiegeleisen to a charge of decarburised iron it is, therefore, unavoidable that a proportionate quantity of carbon must be added for any given quantity of manganese which it is desired to introduce into the charge; and this leads to a difficulty in making very soft kinds of steel, which has always been very seriously felt by all Bessemer steel makers, and has been overcome only to a certain extent by great experience in the management of the converter. The actual necessity for making very soft steel with Siegen spiegeleisen is to "overblow" the charge to such an extent that there is oxygen enough left in the metal to combine, not only with all the manganese and silicum, but also with the greater part of the carbon introduced by the spiegeleisen. This practice has made it possible to apply ordinary spiegel to the manufacture of the softest kind of Bessemer steel; but it is an acknowledged makeshift, which has numerous well-known disadvantages, and the demand for richer alloys of of iron and manganese has, for a long time past, been felt and acknowledged by every steel maker in this country. Mr. Henry Bessemer was the first to point out this demand publicly in his specification for the manufacture and application of a so-called triple compound of iron, manganese, and silicon, instead of the ordinary spiegeleisen, to the manufacture of Bessemer steel. The mode of manufacture of this triple compound, as indicated by Mr. Bessemer, has been practically carried out by Mr. Prieger, of Bonn, and alloys of iron and manganese, reaching occasionally as high a proportion as 60 per cent. of manganese, have been produced by this process. This process has been taken up by several steel makers, but has been finally abandoned, on account of the excessive expenditure which this mode of manufacture involves.

Another process for the manufacture of ferro-manganese has been invented and patented by Mr. William Henderson, of Glasgow, and has been at work for a considerable time at the Phœnix Foundry, in Glasgow, by Messrs. T. Edington and Sons. It consists in reducing upon the open hearth of a Siemens furnace a mixture of carbonate of manganese and oxide of iron in the presence of an excess of carbon, and by means of a neutral or reductive flame. The furnace bottom is carefully prepared from ground coke, consolidated and baked up to form a solid and durable carbon crucible on a large scale. The charged oxides is ground up to a fine powder, and intimately mixed with powdered charcoal or coke, and the whole mass when charged and heated to a red heat for several hours becomes converted into a metallic sponge, containing the reduced metal from both oxides, which is capable of being run down into a regulus by elevating the temperature to a full white heat. The quantity of manganese reduced in this manner is principally dependent upon the high degree of temperature given to the metallic bath at that stage of the operation. For this reason, and also on account of the necessity to avoid an oxidising flame, the Siemens furnace is indispensable for this mode of manufacturing ferro-manganese. With all precautions, however, it is not possible to reduce all the manganese from the charge, and bring it down into the regulus. This is caused principally by the silica which is present in the mixture of ores, or in contact with them during the operation. The affinity of the oxide of manganese for silica is so great that the reduction is almost entirely stopped so long as there is any free silica in contact with the manganese ore. The product of the combination is a liquid slag of a characteristic pale-green colour, and which contains a very high percentage of manganese. The metal entering into this combination is, therefore, altogether lost for the metallic regulus, and only part of it can be recovered by a subsequent utilisation of these slags in other processes. With proper selection of materials, the average proportion of the alloy obtained by this process is from 20 to 30 per cent. of manganese. A furnace of ordinary dimensions, and worked by one man, will produce about 15 cwts. of ferro-manganese every 24 hours. The principal element of expenditure is the cost of the carbonate of manganese, which is subject to considerable fluctuations. At the maximum quotation which this substance now commands in the market, the cost of manufacturing 1 ton of the ferro-manganese of 20 to 25 per cent. is about 7*l.*, independent of royalties; but with improved experience, and by the further development of this process, the expenditure may in all probability be reduced very considerably in future. The value of the rich alloy of manganese to the steel manufacture is very great. For the manufacture of the softest kinds of steel, an alloy contaiuing 15 or 20 per cent. manganese has, at one time, been considered an indispensable addition by many of our leading metallurgists. For this reason the price which steel makers used to pay for this alloy was very high. The rule laid down originally by Mr. Bessemer himself was to rate the ferro-manganese at 1*l.* per ton for every unit of manganese it contained. By this rate the value of the 25 per cent. metal would reach 25*l.* per ton. Commercial experience has, in the course of events, decided against this somewhat arbitrary mode of calculation, and the standard which is now put upon the value of ferro-manganese is taken from the actual price of Prussian spiegeleisen, and compared with the price of a mixture of ordinary hematite pig with that quantity of ferro-manganese which will bring the mass up to the same percentage of manganese as than held by the spiegel. Taking, for instance, the price of spiegeleisen, which averages 7 per cent. manganese, at 7*l.*, the equivalent mixture of hematite iron and ferro-manganese of 21 per cent., will be made up as follows:

Two tons hematite iron, taken at 4*l.*	£	8	0
One ton ferro-manganese, at		13	0
Gives 3 tons of metal, or 7 per cent.	£21	0	0

It appears, therefore, that the commercial value of a 21 per cent. ferro-manganese, under ordinary circumstances in this country, must be taken at 13*l.* per ton as a minimum. It appears equally obvious that the manufacture of these artificial alloys will be a suitable and remunerative industry, and will form a useful accessory to every Bessemer steel works in this country. The steel makers will obtain a better and more regular supply of spiegel, and make their works independent from all accidental fluctuations and inconveniences of the spiegeleisen trade, such as now exist between this country and the Siegen district.

Mr. BELL then said he had to propose the following resolution:—"That the best thanks of the Institute be given to the ironmasters of Merthyr, and South Wales generally, for the cordial reception they have given to the members of this Association." The speaker referred in very gratifying terms to the kindness they had experienced. Not only that had they to thank the ironmasters of Merthyr for, but for their candour in showing their works and explaining their processes, which, after all, was one of the main reasons for which the Institute was founded by the originators.

Mr. FOTHERGILL acknowledged the compliment in very appropriate phrases, and referred to the desire of the South Wales ironmasters to reciprocate the generous hospitality which they had experienced in the North. Having expressed regret at the unavoidable absence of Mr. Crawshay (who, however, was admirably represented by his son), and Sir Ivor Guest (who, however, was fortunate enough to be represented by Mr. Clark, his trustee, and Mr. Menelaus, his active manager, whom they all respected so much), Mr. Fothergill proposed a vote of thanks to the noble President for his conduct in the chair, and referred to the very efficient and valuable services he had rendered to the Institute, notwithstanding his immense and important engagements elsewhere.

The noble CHAIRMAN briefly acknowledged the vote of thanks, remarking that as the time had elapsed at which they were announced to leave for Dowlais, he would not detain them. He could not, however, leave the room without thanking them for for the support and kind consideration they had given him as the President of the Institute. The proceedings on both days had been most pleasing; and they could not help feeling—at least he could not—that the Institute was doing a good work, both when they heard read the interesting papers, and the interesting and well-sustained discussions by which they had been followed.

At the close of the meeting, the members proceeded to Dowlais, where they had an opportunity of inspecting the extensive works of that company, considered the largest in England, and probably in the world. Afterwards, Mr. and Mrs. Clark, representing the Dowlais Company, entertained the members at luncheon, the chair being occupied by Mr. Clark.

THE IRON WORKS IN THE MERTHYR DISTRICT.

The Dowlais Iron Works were first started by the Lewis's of Llanishan, in 1757; joined by Mr. Guest, of Broseley, first as manager of one furnace, which comprised the works, then as partner. The works now consist of 18 blast-furnaces, extensive rolling mills, about 150 puddling-furnaces, and a complete arrangement for the working out of the Bessemer steel process. The works, now the largest in the world, are owned by Sir Ivor Guest; Mr. G. T. Clark being the managing trustee; and Mr. Menelaus, manager. The population of the place (15,000), are, as far as the adults are concerned, employed in the works, and

all dependent upon them. The utilisation of gas was first put into practice here by Mr. Truran. The collieries are very extensive, and a large coal trade is now done. Dowlais is 1½ mile from Merthyr, by means of omnibus or cab, there being no direct railway.

Midway between Merthyr and Dowlais are the Penydarren Works, which, up to the present month, have been idle for a long time. They are now being re-started by Mr. Fothergill, but, for the present, only as far as the refineries and puddling-furnaces are concerned.

The Cyfarthfa Works are situated about three-quarters of a mile from Merthyr. The proprietor is Mr. Robert Crawshay. They comprise 11 blast-furnaces, and 74 puddling-furnaces in work. The average yield of pig weekly is 1300 tons. The capacity of the works is on an average, in full employment, 1000 to 1100 tons of rails, and 200 to 300 tons of bars. The monthly yield of coal varies from 10,000 to 20,000 tons. A line of rail extends from the Cyfarthfa to the Gethin and Castle pits, the latter of which has been sunk of late to the lower 4 feet. In compactness and orderly arrangements Cyfarthfa takes the lead of the South Wales works.

Plymouth Works, which with Abernant, Llwydcoed, the Taff Vale, and Penydarren Works, are owned by Mr. Fothergill and partners, are in three divisions, Plymouth, Pentrebach, and Duffryn. At the first there are three furnaces in blast and two out. At Pentrebach the forges and mills are located: at Duffryn there are four furnaces in blast and one out. Formerly, in Mr. Anthony Hill's time, the cold-blast principle was the one in use; but, in the opinion of the present proprietary, this was considered better adapted for merchant iron, and now the hot-blast is being partially adopted. The mills of Pentrebach possess many additional features, the mechanical arrangements in particular being worthy of notice. The utilisation of water, too, is a speciality to be seen at Plymouth, Pentrebach, and Duffryn. At Pentrebach, a turbine is to replace one of the water-wheels, and apparently to advantage. There are 78 puddling-furnaces at Plymouth Works. The average yield of the blast-furnaces now in operation is about 1000 tons of pig-iron, and the mills are capable of turning out fully 700 tons of rails, and 400 tons or 500 tons bars weekly. Mr. Fothergill has made the preparation of coal for the coke ovens a special study, and the process of mixing the bituminous coal with the screenings of the steam coal is worthy of note. In the beginning of the Plymouth Iron Works, three colliers only were employed. Coal is now raised for sale as well as use. There are seven coal pits and six levels at Plymouth; 1400 colliers are employed, and the yield is about 30,000 tons a month. In addition, there are four mine pits and six levels, which produce nearly 3000 tons a month. Penydarren Works, long in disuse, are now being restored, principally, for the present, with the view of supplying puddled bar to the Taff Vale Works. This will benefit Aberdare Works also. One feature of Plymouth Works deserves a note—the replacement of the old tramway system by rails and locomotives.

Gadlys Aberdare, four miles west of Merthyr, reached by the Vale of Neath Railway. The number of furnaces in blast, 2; out of blast, 2; puddling-furnaces and balling, 37; weekly make of rails, 250 tons; and of tin-plates, 120 tons. In connection with the works are extensive collieries, employing 1800 to 2000 men, and capable of turning out 700 to 800 tons per day. It is a noticeable fact in connection with these works that Mr. Wayne, the founder, was the first, after the owner of Wernlaes, to bring steam coal into repute, and make it an article of commerce. Wayne's Merthyr steam coal gained the "Diplome d'Honneur" at the French International Exhibition of 1867. Gadlys is also celebrated for its cold-blast foundry pig-iron. The Millwall shield, which withstood the most powerful gun in the world, and the Armstrong 12-in. 600 pounder, was made from Gadlys iron.

The Abernant Works are situated at Aberdare, four miles distant from Merthyr, and are accessible by the Taff Vale and Vale of Neath Railways. They are the property of the Aberdare Iron Company (Messrs. Fothergill and Co.), and are composed of four blast-furnaces and 78 puddling-furnaces. The average yield of pig-iron weekly is 1200 tons. The works are capable of bringing out 1000 to 1100 tons of rails weekly. There are seven coal pits in connection with the works, capable of turning out daily 1100 tons of coal. The rail-mill arrangement at Abernant is a speciality, and a good feature is considered the driving of nearly all the machinery by separate steam-engines. In connection with these works are the blast-furnaces at Llwycoed.

The principal iron works in Monmouthshire are easily accessible by rail. They are—first, the Rhymney Iron Works, of late carried on by a limited liability company, and successfully. These are situated about four miles from Merthyr, and midway between the Merthyr and Tredegar Iron Works, the latter with nine furnaces, a flourishing establishment, conducted on a large scale by Messrs. Rowland Fothergill and the executors of the late Mr. Forman, of Hensol. Next, we have Sirhowey Works, Victoria, and Ebbw Vale, formerly under the proprietary of Mr. Darby and others, but now a joint-stock concern. At Ebbw Vale the steel process is carried out, and to a large extent. The works are 12 miles north-east from Merthyr, accessible by coach and rail. Nantygio Works, the property of Mr. Crawshay Bailey, are amongst the most extensive in Monmouthshire. They are 13 miles from Merthyr, near the Abergavenny road. The Blaenavon Iron Works, now the property of a limited company, comprise about 90 puddling-furnaces and nine blast-furnaces. The works produce about 42,000 tons of finished iron per annum; 6000 tons of pig-iron and nearly 400,000 tons of coal are raised. The works employ about 7000 persons. The specialities of these works are cold-blast pig-iron, steel-iron, tyres, &c.

Clydach in Monmouthshire, and Aberaman and Hirwain in Glamorganshire, are at present not in operation.

—*The Iron and Coal Trades Review.*

THE SULPHUR SPRINGS AT CHILLINGTON AND CODSALL WOOD.

A meeting of the South Staffordshire Institute of Mining, Civil, and Mechanical Engineers was held on Monday at the Exchange, Wolverhampton, principally to listen to a paper by Mr. DANIEL JONES, F.G.S., of Kilsall, who is officially connected with the Coal Commission, upon "The Sulphur Springs at Chillington and Codsall Wood, localities between the South Staffordshire and Coalbrookdale Coal Fields." The subject is regarded as an important one, inasmuch as it is supposed to have a bearing upon the question which the Institute has several times discussed in one form or other since its formation, whether there exists any workable coal between the coal fields of South Staffordshire and Shropshire; and Mr. Jones's paper, and the discussion it elicited created much interest. The chair was taken by Mr. J. P. Baker, Her Majesty's Inspector of Mines for this district, the President of the Institute, and among other members present were Capt. Groucutt, Messrs. T. Rose, J. W. Baker, J. Gethen, S. Watkins, H. T. Griffiths, J. Hodgkiss, T. Laxton, S. Fenn, J. Davis, jun., E. Meacham, W. Blakemore, A. Hand, D. W. Lees, J. Cope (hon. sec.), &c. After Messrs. William Bickley and Wm. Fenn had been elected members,

Mr. JONES introduced his paper with a brief description of the geological features of the locality to which the paper referred, illustrating his remarks by a coloured map showing the site of the springs, the South Staffordshire and Coalbrookdale and other coal fields, and the country lying between our own and the Shropshire coal districts. He said the geological survey maps for the district showed that the outskirts of a large area (ranging to the north and north-west) of red marls belonging to the Keuper division of the New Red Sandstone covered or bordered upon the locality referred to in his paper. The existence of springs of water impregnated with sulphuretted hydrogen at Codsall Wood, in the dingle below Chillington Pool, and at the "Leper Well," near Gunstone had been known for many years—indeed, as to the "Leper Well" for many centuries. In August, 1869, he made some enquiries in the neighbourhood respecting these springs, and found that the spring at Codsall Wood issues from the trunk of a decayed tree on the left side of the road as we proceed thence towards Codsall. This water was said to improve the skins of horses that drank it, and was known to be an excellent medicinal water for use at spring time. Some years since, when more attention was paid to such remedies for cutaneous disorders, or when the existence and merits of these springs were better known, people sent for the water from considerable distances. The water was now very little employed, and indeed very little seemed to be known about it. Below the Chillington Pool, in a dingle, was another spring from which the sulphurous water was pumped by those who required it. The pump was erected by the late Mr. Giffard, of Chillington Hall, for the use of his family and friends. It was known in the neighbourhood as the "Brimstone Pump." The "Leper Well" was probably the most important of these springs. It was situated in a meadow on the right side of the road leading from Codsall Wood to Gunstone, and a little beyond the "Leper House." You enter the meadow by a gate, and turning immediately to the left, beneath the shade of two alder trees, which grew in the hedge row, was the "Leper Well." An oval brickwork formed the sides, and steps were provided—no doubt for those lepers who in former times used it as a bath. The water of this well was described to him as being remarkably cold, but not sulphurous, by those who were certainly likely to know. He found it, nevertheless, very sulphurous, and it required no delicate test to discover this, for the taste was quite sufficient to convince one, or if the water were disturbed it gave off a strong smell of sulphuretted hydrogen. Thus he had satisfied himself that within an area of a square mile there were at least three well-ascertained springs giving off sulphuretted hydrogen gas. The sources of this gas, when it was met with constantly emanating from the earth, might be ascribed to active, dormant, or extinct volcanoes, or to the decomposition of pyrites—a name given to sulphur in combination with certain metals; and, so far as he was at present informed, to one or other of these causes they might ascribe the sulphuretted hydrogen issuing from the earth in springs or otherwise. Springs of this character were found in a variety of places issuing from stratified deposits containing large quantities of iron pyrites. [In proof of this Mr. Jones quoted from several scientific works.] The Chillington and Codsall Wood springs bore some analogy to a case at Newent, mentioned by Sir R. Murchison in his "Silurian System." They had the New Red Sandstone as the subjacent formation, and they had the tilted coal measures ranging from Brownhills and Pelsall to Bloxwich and Walsall. Then the question arose—had they at any depth in the neighbourhood of Chillington strata likely to contain iron pyrites in sufficient quantity to keep up a supply of sulphuretted hydrogen to the three springs noticed, and which, so far as they knew, had been thus flowing since the memory of man? They had the lower part of the Keuper and the Bunter division of the New Red Sandstone, and probably the Permian formation, but in none of these was any considerable quantity of iron pyrites found. Below these, however, they might have the coal measures, and seeing that they had them cropping out at no great distance, both to the east and the west, it was reasonable to suppose they existed there. If there were coal measures beneath they would be of the same character as those met with in the neighbouring coal fields—i.e., the older coal measures only, or having upon them a zone of the younger coal formation, such as Sir R. Murchison spoke of at Newent. Although iron pyrites, unfortunately for the iron smelter, is met with to a certain extent in both these zones of the coal measures, it was not met with in sufficient quantities in the neighbouring coal fields, in any case that he knew of, to give rise to sulphur springs. After many enquiries, in several coal fields, excepting at Admaston, he had been unable to hear of any such spring. It might happen, of course, that in coal measures beneath these springs at Chillington, for some cause or other, a greater concentration of iron pyrites existed, even as they found it did at Newent, as described by Sir R. Murchison. In concluding an able paper, Mr. Jones said he had no doubt in his own mind that the sulphuretted waters of Chillington and Codsall Wood owed that character to the decomposition of iron pyrites going on at some distance beneath the surface, but whether that pyrites existed in strata contiguous to some trap dyke, fault, or mass of trap, or whether it was contained in some sedimentary strata beneath, such as the coal measures, it was at present impossible to decide. It would, no doubt, be within the power of many there to throw additional light upon the subject from their own experiences. (He concluded amidst applause.)

The PRESIDENT said they must all feel much obliged to Mr. Jones for his very valuable paper. For his own part, he regarded it as one of very great importance to the Institute, and he should be glad if any gentleman having experience of any similar springs would bring it to bear on the paper just read.

The SECRETARY, in answer to Mr. Jones, said there were saline springs, but he was not aware of any sulphur springs in the South Staffordshire coal field.

Mr. JONES remarked that the fact of the locality of the springs forming a sort of puddled basin for the water to accumulate in between the two coal fields, the coal measures being impervious to the percolation of water, seemed to be a natural explanation of there being a spring at that point.

Mr. FENN thought the sulphurous character of the springs arose from the water flowing over "stink coal."—Mr. JONES said it arose from the fact either of there being trap rock beneath upon the line of the fault, the sides of the fault being studded with pyrites, or else it was due to the percolation of water over the surface of the coal measures—the outcrop—gradually getting deeper and deeper, and rising to its own level by gravitation at some weak point.

Mr. JONES, in answer to a question, said there was no telling without boring from what depth the water came. Some hundreds of years ago a charitable person erected a hospital, called the "Leper House," as a lodging-house for leprous people who went for the benefit of the waters. These people used the still existing bath, and the water could be seen bubbling up from the bottom.

Mr. BLAKEMORE observed that he thought with Mr. Jones that the existence of these springs was due either to trap rock or else to the proximity of iron or copper pyrites—which of the two he did not think it easy for any of them to decide. He moved a vote of thanks to Mr. Jones for the very interesting and instructive paper he had read.

The PRESIDENT (to Mr. Jones): You think it probable that coal of some kind, probably sulphur coal, may exist not far away from these springs?—Mr. JONES replied that he should not like to say he thought coal existed, but he thought the springs evidenced the existence of coal measures somewhere about. His own impression was that the springs were due to the percolation of water which collected on the higher ground near Cannock, passing, by its own gravity, under the Permian and New Red Sandstone, into the low basin of which he had spoken, not being able to get out because of the impervious nature of the coal measures, and then rising up in the weak point in the basin.

The PRESIDENT was strongly of opinion that water did not come from Cannock at all, as a deposit of marl would prevent its percolation in the way Mr. Jones suggested, and in confirmation of this opinion he said that borings had been made at Wedge's Mills and Laney Green, and though there were springs they were not sulphurous.—Mr. BLAKEMORE suggested that even if the way was clear for sulphurous water to run from Cannock to Chillington it would be likely to be deprived of its sulphurous properties by filtering through the Red Sandstone.—The PRESIDENT thought the peculiar character of the water was due to some local cause.—Mr. JONES did not think the water obtained its sulphurous character in the neighbourhood of Cannock, but after it passed under the New Red Sandstone, and from flowing over a surface containing iron pyrites.

The PRESIDENT remarked that it was important the subject should be enquired into further, but the only way to arrive at a satisfactory conclusion would be by a boring. If the matter were investigated fully, as the Institute was thinking of a trial pit to test whether there was coal between the South Staffordshire and Shropshire coal fields, it might lead them to the right spot to sink it.—Mr. JONES said it was with that view he proposed to read the paper.

It was then agreed to adjourn the discussion until the next meeting, in order that some important members of the Institute not now present might have an opportunity of speaking upon the subject.

The PRESIDENT, in conveying the thanks of the meeting to Mr. Jones, said there could be but one opinion that the Institute was much indebted to him for the trouble he had taken in preparing a paper of such merit. (Applause.)

Mr. JONES, in acknowledging the compliment, said he had many papers by him relating to the question of the development of the coal field between Shropshire and Staffordshire—one of which he hoped would be published in the Coal Commission Report, and some others which Prof. Ramsay had looked over and approved of, and when he was a little more at liberty, and not officially connected with the Coal Commission, he should be glad to read them before the Institute.

EXTRACTING THE PRECIOUS METALS WITHOUT QUICKSILVER.

The great and apparently unavoidable loss of mercury in the extraction of gold and silver from their ores must cause considerable interest to be felt by all engaged in mining for those metals in processes which render the use of quicksilver unnecessary, more especially when, as in the case of the process to which most prominence is given in the volume* just completed by Mr. G. Kustel, M.E., whose works on the metallurgy of the precious metals are already favourably known among practical men, simplicity and economy are combined. The chief aim of the work is to explain the leaching, solving, and precipitation process for silver ores now successfully practised in Sonora, Mexico, where it has been lately introduced by Mr. Ottocar Hofmann; but to enable those relying upon the book to ensure success, he devotes three-fourths of the volume to the consideration of preliminary processes, upon the careful carrying out of which much, of course, depends. Referring to roasting, he observes that, as it is regulated by the peculiarity of the ore, and by subsequent treatment, it is impossible to give any one way which will be suitable in every case. The descriptions of the roasting processes are followed by accounts of the lixiviation process, and of the gold extraction processes, so that a complete handbook for practical men is thus supplied.

Ores may be classified, Mr. Kustel observes, according to the metal the extraction of which is principally remunerative, as silver ores, lead ores, copper ores; according to the metallurgical treatment, as roasting ores, smelting ores, amalgamating ores; according to the predominant gangue, as calcareous ores, quartzose or ochrey ores; or according to the predominant metallic mineral, as sulphuret ores, chloride ores, carbonates, &c.; and he then gives brief descriptions of the more important silver ores, the difference between real silver ores and argentiferous, and of some of the more important combinations met with. Sulphur, he says, is the most formidable obstacle to the metallurgist in extracting metals from their respective ores. Desulphurisation has been a subject of most diligent and numerous experiments. The oldest method is the application of heat, which is still in use, notwithstanding the many attempts in modern times to dispense entirely with fire, or to modify its application, so as to perform the process more perfectly, and in a shorter time. The desulphurisation of ores is effected by heating with free admission of air. This is the common way of roasting, and the most important, and is effected either in kilns, heaps, &c., or in reverberatory furnaces; by heating with exclusion of air, only the sulphides of gold and platinum are decomposed perfectly by this method; by superheated steam, and by heating with materials for which the sulphur has a greater affinity. The general effect of roasting is that the metals are oxidised. Only gold and silver are transformed into a metallic condition, and of the silver, moreover, a large percentage is always found as a sulphate, even when the roasting is well performed. The most powerful agent of reduction is carbon (charcoal, coke, &c.) and carbonic oxide. Metallic oxides in solution are reduced and precipated in a metallic condition by other metals, or by the aid of electro-galvanic action. Although by mere desulphurisation the silver is to a great extent converted into a metallic state, this is not always the most suitable condition except for smelting. It would seem as if metallic silver should amalgamate more easily than if combined with another substance, yet this is not the case. The silver, after roating, is generally coated with the oxides of volatile base metals, which prevent its ready amalgamation. A momentary contact in a muddy pulp is not always successful. The chloride of silver, however, goes into solution, and unites easily with the quicksilver. Hence in most instances it is necessary to adopt a chloridising roasting. For this chlorine must be brought in immediate contact with the ore particles. The cheapest material evolving chlorine is salt, from which the chlorine is separated by substituting a substance with stronger affinity for sodium. In practice, sulphuric acid is used to convert the chloride into sulphate of soda, and thus set the chlorine free. The two principal methods of chloridising are by roasting the ore with salt in a furnace, and by passing cold chlorine gas through the roasted ore. The silver is easily obtained from the chloride by melting it with alkalies; the chlorine unites with the alkaline metal, and the silver separates on the bottom of the crucible.

In the chapter treating of the roasting of ores it is explained that in order to chloridise the ore an addition of common salt is indispensable. The salt furnishes chlorine for that purpose, and is decomposed by sulphuric acid. The sulphuric acid is created by the decomposition of sulphurets present in the ore. It follows that if silver ore is to be roasted successfully with salt there must be a certain percentage of sulphurets in it, otherwise no sulphuric acid can be obtained, and, consequently, no chlorination, or at least only a very imperfect one, can be effected. In Nevada and Idaho the ore only contains from 6 to 10 per cent. of sulphurets, yet gives a good result. As no pyrites are within reach the want of sulphuric acid must, when necessary, be made up by the use of some other substance, such as green vitriol or copperas. As to the amount of salt to be used, and when, Mr. Kustel states that ores containing from 80 to 100 ozs. of silver to the ton should be mixed with 10 per cent. of salt. Rich ore is often roasted with 20 per cent. of salt. If all the chlorine of the salt could be transferred to the silver an insignificant amount of salt only would be required for ores containing 100 ozs. of silver—not more than 3½ lbs. to the ton; but, in consequence of the different way in which the chlorine decomposes and unites with base metals and gases, the escape of chlorine from the surface of the ore without coming in contact with the silver, &c., a great deal more of the salt must be applied. Permanent stirring is not essential, and Mr. Kustel remarks that a good chloridising roasting should give over 90 per cent. of the silver converted into chloride of silver, and show as little as possible of base metal chlorides, which are formed under the action of chlorine and hydrochloric acid. When endeavouring to expel the base metals by heat the loss of silver in presence of much antimony, lead, and copper should be investigated very carefully. Under certain circumstances it is not uncommon to find a loss of even 50 per cent. of silver if the chloridising roasting is carried on at a high heat for a great length of time. The formation of base metal chlorides can be avoided by a proper but more expensive roasting. It requires, first, an oxidising roasting with the application of steam. This roasting must continue until all the metals are desulphurised and converted into oxides. When this is accomplished salt and green vitriol are added, and the roasting continued until all the silver is chloridised. There is also a very good way of getting out a great deal of the base chlorides of the ore before the silver is amalgamated or extracted by leaching the ore with hot water.

The importance of a knowledge of the condition in which the metals exist after roasting is very great to the practical man. Mr. Kustel, therefore, considers it very fully; and with reference to oxidising roasting, he states that its purpose is either to expel volatile substances which are combined with the metals, as sulphur or arsenic, or to expel volatile metals, which are considered obnoxious to the further treatment of silver ores (as antimony, lead, zinc, &c.) The oxygen has a large share in this transaction, and combines with the volative substances as well as with the metals. After describing the leaching principles of the roasting processes, Mr. Kustel refers, with diagrams and details, to the several furnaces in which the roasting is effected, and then explains the object of leaching. The roasted ore contains chloride of silver, which does not dissolve in water, but generally there are also base chlorides in it, as the chlorides of copper, zinc, lead, iron, antimony, &c., which are soluble. It is the purpose of the first leaching to extract these base metals by means of hot water. The ore is introduced into a square box of pine wood, the planks being 1½ in. to 2 in. thick. The boxes must be made as watertight as possible, and provided with a filter at the bottom; in these the base chlorides, soluble in water, are first thoroughly washed out, after which a solution of hyposulphite of lime is led into the tank to dissolve the chloride of silver. The liquid of the second leaching is conveyed through a trough or India-rubber hose to the precipitating tank, of which three or four are employed. The black precipitate of sulphide of silver is conveyed directly into filters made of canvas, either in the shape of pointed bags or otherwise. Mr. O. Hofmann, in need of sulphur for the production of sulphide of calcium, calcined the dried silver in iron retorts, and thus obtained a large proportion of sulphur as a fine sublimate; after this is removed the calcination can be finished with access of air.

But perhaps the most important process described in the book is that of Kustel and Hofmann, by which the roasted ores are so treated that the copper, gold, and silver can be obtained separately. The ore is moistened, and then treated with chlorine gas, obtained from a generator of simple construction. The vessel is uncovered, and for a charge of 3 tons of roasted ore the ingredients introduced are—pulverised peroxide of manganese, 30 lbs.; common salt, 30 lbs. or 40 lbs., according to quality; sulphuric acid of 66°, 75 lbs.; and water, 45 lbs. Salt, manganese, and water are introduced first, the generator covered, and the hydraulic joints made tight. The sulphuric acid is then charged through a syphon funnel in small amounts—20 to 25 lbs. are sufficient to evolve the chlorine and the required heat. When the evolution of chlorine becomes weaker 20 lbs. more of acid are administered, and after some time the rest of the 75 lbs. It will be necessary now to build a fire beneath the generator, which is placed on tiles that the heat may not injure the leaden bottom, which is made of 16 lb. sheet lead, while the sides are of 8 lbs. The chlorine is washed before it reaches the ore, through the whole mass of which the chlorine passes. As soon as the ore box is filled with chlorine the outlet is closed, and the fire withdrawn. In this condition the ore is left for 12 or 15 hours. The gas is then removed into another ore-box, hot water is introduced into the first-named box, and the leach run into the precipitating-box, where the gold is thrown down in a metallic state by sulphate of iron. The extraction of gold without the use of quicksilver is limited mostly to those ores in which the gold is not free in a metallic condition, but combined with sulphur or arsenic in the respective pyrites.

Although the book contains less than 150 pages, it will afford all the information likely to be required upon the subject, and the illustrations of furnaces, implements, and working apparatus are excellent. It gives a condensation of most that has already been published either in German or English with reference to the extraction of the precious metals, and contains much that is new in the way of descriptions of inventions to which the experience gained in the extensive mining operations carried on in the Pacific States have given rise. The merit of the work is beyond question, and as it is certainly as cheap a half guinea's worth as could be purchased by those for whom it was intended, the prediction of the author—that its chances of doing much good are far better than the probabilities of its repaying its author and publishers—is one which happily is not likely to prove true; it will doubtless find an ample number of patrons, both in the Old World and in the New.

* "Roasting of Gold and Silver Ores, and the Extraction of their Respective Metals, without Quicksilver." By G. KUSTEL. San Francisco, California: Dewey and Co., *Scientific Press* office.

GREAT NATURAL SODA MINE.—The Nevada Soda Mine, owned by Mr. JAMES DUFFY, of Carson, proves to be a more extensive deposit, and consequently a greater fortune to the proprietor, than was at first supposed. It is in the midst of a great desert (the lower portion thereof), is about seven acres in extent, and of unknown depth, having been prospected in the pure article, with but slight interruption, down 18 feet. At the depth of a few feet the soda is quarried with sledges and wedges, being more solid than ice, which in some respects it resembles in appearance. The supply would seem, from present prospects, to be inexhaustible, as the article is in constant process of formation. In the spring the mine is frequently several feet under water. The quartz mills supplied with ore from the Comstock lode use about 20 tons of this soda per month, at a cost of about $80 per ton.

THE QUICKSILVER MINES OF ALMADEN.—From an official document we learn that the net produce of pure metal for the year 1866, after smelting, was 9550 metrical quintals, the money value being in round figures about 200,000*l*. There is now at Almaden a very prosperous school of mining. One of the chief evils in connection, not alone with these quicksilver mines, but with the mines of the whole Sierra Morena district, so rich in various minerals—want of facilities for transport—will be obviated by the new line of railway, which is nearing completion.—*United States Railroad and Mining Register.*

REFINING LEAD.—By the invention of Mr. G. E. FAWCUS, North Shields, when lead containing zinc, antimony, and other impurities has been melted in a suitable iron pot to a red-heat, an air-tight cover is luted with clay on to the pot, and superheated steam is then introduced from a suitable boiler or apparatus by means of a pipe near the bottom of the molten lead, saturated steam being also admitted by another pipe above the molten materials. The steam and such fumes as may arise are carried away by a pipe through the cover and passed into a condenser. This process is continued till it is found that the liquid mass has parted with the zinc, which is then skimmed off in the shape of an oxide, and then either the cover to the pot is taken off to admit fresh air, or a jet of air is forced in through the cover into the space above the lead to oxidise the antimony, the superheated steam being still applied to the mass. On this oxidised antimony being removed the residue is almost chemically pure lead.

PISTON PACKING.—Messrs. G. D. KITTOE and P. BROTHERHOOD, Clerkenwell, fit in a recess or groove in the working surface a metallic, or in some cases a hard wood, ring, which is split and tongued, or it may be several split rings arranged so as to break joint, and behind these rings are placed a double-flanged ring of caoutchouc or other elastic substance, the flanges of such ring being made to bear against the sides of the recess, and the face of the ring bearing against the back of the metallic or hard wood rings.

IMPROVEMENTS IN RAILWAYS AND RAILWAY PLANT FOR COLLIERIES.

The Emperor of Russia having sanctioned the construction of a line of railway, upon the system invented by Mr. JOHN TIRANOFF, of St. Petersburg, from that city to Tsarko-Selo, about 25 versts distance, where there is a royal palace, in which the Emperor spends the greater part of the year, and as the invention appears to be particularly applicable to colliery lines, some account of the improvements suggested will be generally acceptable. The object in view is naturally to reduce the wear and tear of the permanent way and of the plant to the minimum, to necessitate as little labour as possible, and to ensure perfect safety under all circumstances. In order to carry out so large a programme, Mr. Tiranoff has necessarily had to give his attention to various points connected with the railway material, and thus it is a series of inventions rather than a single invention, which the annexed diagrams refer to; for he proposes not only to provide against the carelessness of signalmen and pointsmen; but to render even such casualties as the breaking of a wheel entirely free from danger. A frame with small wheels on adjustable axles is placed beneath each carriage, so that should the travelling wheel break the small wheel immediately behind or before it, as the case may be, and which until then has just brushed the rail, will at once take the load. No sooner does this change take place than the fact is communicated to the guard or driver through the release of a bar tightening a cord in communication with a whistle or other sound-creating instrument.

The arrangement for facilitating the movement of the carriages round curves consists in arranging the wheels in pairs upon a pivoted bogie, which is free to adjust itself to the curve by friction rollers moving upon a circular plate under the carriage. The periphery of the travelling wheels are made to taper the reverse way to that which is usual, the smaller circumference being nearest the flange. The advantage of this arrangement is that in turning curves the larger diameter of the periphery being at the edge the sliding of the whole carriage laterally is prevented, and the sudden crush of the flanges against the inner rail avoided. The rails on which the carriage run are preferably of the Vignoles kind, and to enable the small wheels to pass the meeting ends of the rails fish plates are dispensed with, and the rails are supported in a kind of arched shoe at the meeting points only.

The invention, says the *Mechanics' Magazine*, to which we are indebted for the annexed engravings, contains so many novelties that we have had wood-blocks made of it, so that it shall be clearly understood. Fig. 1 is a transverse section of the lower frame of a railway carriage or truck, in which the apparatus is fitted for preventing the vehicle leaving the rails. Two sets of apparatus are shown, one in elevation and one in section; *a a* are frames or boxes, fitted to the vehicle in such a manner that they are free to rise and fall within certain limits between guides or horn plates, *b b*, which are rigidly bolted to the sides and transverse frame pieces of the carriage. The frames or boxes, *a a*, are arranged in their interior parts with collars, washers, or bearings, *c c*, for the reception of vertical axles or pins, *d d*, of two horizontal wheels, *e e*, which are so arranged that they come below the tread or bearing surfaces of the rails to prevent the carriage leaving the track should the latter, by accident or otherwise, become disabled. The collars or bearings in each box also support the axle of a vertical wheel, *f*, which is free to run upon the rail under all conditions of level. The collars or bearings of each box are carried by a block, *g*, which terminates in a stem, *h*, at the upper part, and projects through the top of the box, and is fixed to it by a bolt, *i*. This stem is slightly tapered, and rides against two rollers, *j j*, on the horn plates, which act as guides to it. The top is pressed upon by a link, *k*, which has one end pinned to the side beam, or main girder of the carriage frame, as shown, while the other end is connected to a hanging link, *l*, leading from a pivoted link or bar, *m*, which is centred upon a pin at *n*. The hanging link, *l*, has a loop or a transverse pin for a spring, *p*, to bear upon to enable a sufficient pressure to be exerted upon the stem and vertical wheel to keep the vertical wheel, *f*, upon the rail. The free end of the pivoted bar, *m*, terminates in a rounded claw, or projection situated over a catch, which is retained in a locked position by a spring, Fig. 3, while the carriage is in a proper travelling condition. This catch is caused to hold a rod, *q*, and a spring, *r*, connected to it in a compressed or contracted order, while the mechanism before spoken of is kept intact, but the instant an accident happens to the train, such as the breaking or the coming off of a wheel, the carriage sinks to a lower degree at that part, and causes the box to travel, so to speak, up the horn plates; thus the tension of the spring, *p*, is overcome, and the bar, *m*, presses upon the catch, *s* (Figs. 2 and 3). By this means the rod, *q*, is freed from the grip of the catch, *s*, and its spring, *r*, causes it to rebound, so that a cord which is fastened to it may be the means of a gong being sounded in the guard's compartment, or of the whistle on the engine being opened to give the alarm.

Fig. 4 represents two of the apparatus before spoken of fitted to each side of the carriage frame with the horn plates fitted in a rigid manner, and in many cases this would be advisable, but in others it is preferable to arrange a set of supplementary wheels in front of and behind each bearing or travelling wheel of the carriage or carriages forming a train. In that case the supplementary wheels and boxes should be in connection with a swivelling or bogie frame, so that perfect freedom in turning curves is obtained. Figs. 5, 6, and 7 show how the boxes, &c., are arranged to the bogie frame: *x x* are plates for carrying a set of rollers which bear against a curved or circular plate or ring or portions of a ring, *y*, to enable the bogie to turn and arrange itself to the curve or curves of the line of rails. The bogie frame is provided with slotted plates, to serve as the ordinary horn plates to receive the axle-box of the wheel-axles, the axle-boxes being acted upon by springs in the well-known manner, and to enable each of the travelling wheels to follow the curves in as free a manner as possible; to reduce friction, each pair are arranged upon separate axles, as shown in Fig. 8. The axles are provided with shoulders, which are recessed into bearings or brasses, and retained in place by two half sockets, which can be firmly bolted together. The spaces between the brasses act as oil-cups, and only sufficient lubricating matter can escape to grease the axle and bearings from the spaces, as is required for the purpose. Fig. 8 also shows the wheels with the tyre shaped in the manner before explained—that is, with the taper or incline running from the outer edge towards the flange to compel the wheel on the outside radius rail to travel upon its largest base or diameter, and thus, as it were, overtake the opposite wheel, which would be running upon a smaller diameter; each one by this method adjusts itself to the speed at which the trains may be travelling.

This mode of making tyres, the inventor says, completely avoids the strain and friction which one wheel generally puts upon the other in passing round curves when they are made in the ordinary manner; but should it be necessary for one or more of the carriages forming the train to be fitted with this apparatus to enable it to pass on to an ordinary or an existing line of rails, the frames carrying the horizontal and vertical wheels, with the peculiarly constructed levers, would be arranged with a mechanism of another kind, so that one or the other of the wheels could be raised to such a height that they would be clear of the rails.

Again, instead of these horizontal wheels, a pair of horizontal wheels are fitted in the front and another pair at the back of the locomotive, on the inner side of the rails; these can be lowered to move the points, as shown in Figs. 13 and 14. These wheels should be preferably retained in their raised position by means of springs, and fitted with levers, chains, or other appliances leading up to the driver or to the guard, as desired, so that they can be raised or lowered into position for shifting the points as found requisite, and in many cases it will be advisable to make them act in that manner, so that the driver or the guard can shift the points to admit the train into a siding or branch line without the necessity of a special attendant being engaged for that purpose. When the horizontal wheels are arranged according to this method the ordinary permanent way is not interfered with, as the horizontal wheels can be lifted and kept in a raised position in stations and various other places where the points are numerous, or when the shunting takes place in a station or near warehouses. It is not essential that two sets on any carriage should be connected so that both should be raised and lowered together, as each set must then have a motion independent of the other, and it will be found of advantage to shift the points on one side of the line only, and the connection links or bars of the points will cause the opposite point rail to move with it. The links may be dispensed with as they would be when the point or fly rails are connected by tie-rods.

Fig. 9 gives a section of the ordinary flat fin rail, A. The chair, B, is formed with overlapping lugs or clips, which only reach over the upper surface of the fins, C C, of the base. The central part of the chair is made thinner than the sides, so that should there be any tendency to yield under the weight of a passing train the central part should be enabled to bring itself flat upon the sleeper, and at the same time cause the lugs to clip the rail with greater power, and keep it upright. The under face of the rail is tapered from the centre to the edge of the fin, so that the rail rests, so to speak, upon a pivot or knife edge longitudinally formed by the central line of the base. This mode of making the base allows of the chair yielding freely, and prevents a fracture taking place. The chairs are held rigidly to the sleepers by dog nails or spikes being driven through them.

The vertical web of the rail is unencumbered by the cheeks of the chairs, or by keys, trenails, or other appliances, nor are there any fish-plates or bolts at the meeting ends of the rail to obstruct the movements of the horizontal wheels as they are carried along by the carriage. Guard or check rails are also dispensed with, as the clip chairs are sufficient to hold the ends perfectly secure, and prevent all "swageing" of the rails, even when the flanges of the wheels are pressing upon the sides in passing round curves, or when one side rail is of a higher level than the other. It is before mentioned that this system of opening points may be entirely under the control of the driver or of the guard, or of both of them, and Figs. 10 and 11 illustrate how this is to be accomplished. Take, for instance, that of a train coming along a branch line or siding to get on to a main line, and the points being set for the main line, it would be moving in the direction shown by the arrow at D D. Now, as the first set of horizontal wheels at the front part of the engine came near the points they would come against bars, E E, and force them outwards, causing the points F F to move with them into the position shown at Fig. 11, where they would remain until shifted back to their original position at the main line by the passage of a main line train, which would pass along the metals G G, and in doing so the front set of horizontal wheels of that train would ride against the bars, H H, to shift the points or fly-rails into the proper position to allow it to pass—that is, as seen at Fig. 10. The bars, E E and H H, are centred or pivoted into shoes or sockets, J J J J, which are bolted down to the sleepers, as shown, so that they partake of no movement except that given to them by the passing trains. These two views represent the same line of rails, and are only given to show the two positions the points are moved into by trains on the branch or the main line, and if these rails are considered as being the up rails a duplicate set of bars is fitted for the down rails, only in the reverse direction, so that all up trains can shift their own points, whether it is necessary for them to pass from an up branch or to continue on the main up line. Fig. 12 shows how only one point or fly-rail could be used, so that it could be shifted to suit either the branch or the main line traffic. The rail is centred upon a stud at K, and the movement of the bars causes it to move in the required direction, in a similar manner to that before mentioned.

So far the invention is equally applicable to ordinary passenger railways and to colliery lines, but the part which appears to be more especially adapted to the latter is that for giving the engine-driver the power of changing the switches, so as to pass from one line to another without slackening his speed, or risking the carelessness of a pointsman. In the case of colliery lines, the necessary fixtures would be fixed to the trains themselves, so that their passage on to a wrong line would be practically impossible. To enable the small wheels to pass the points or switches automatically, the horizontal wheels are made to strike or roll against a lever or levers just in advance of the points, to force them outwards or inwards to shift the point or switch rails, so that the train can pass from a branch to a main line, or *vice versa*. In one case the rail is centred at one end, and the free ends are connected to an arrangement of levers, bent or not, which are forced outwards or inwards by the train as it travels to take the rail with them to the proper sides. By another method the point or switch rail is supported upon a pivot at the centre, and the horizontal wheels

FIG. 1.

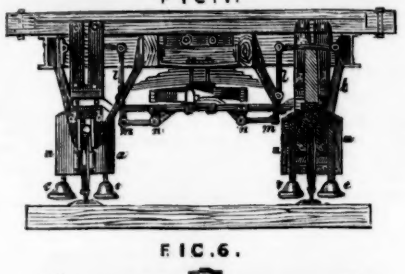


FIG. 4.

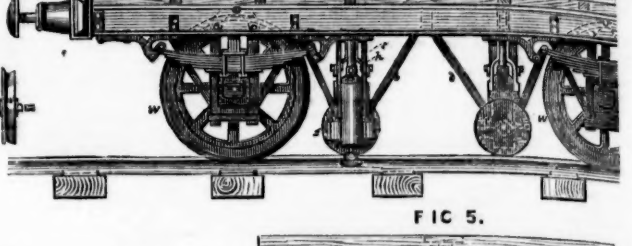


FIG. 8.

FIG. 6.

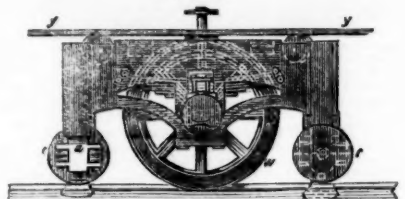


FIG. 2.

FIG. 3.

FIG. 5.

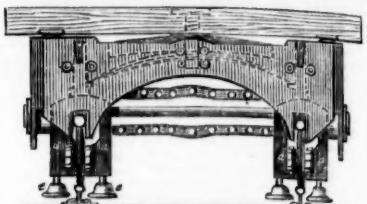


FIG. 7.

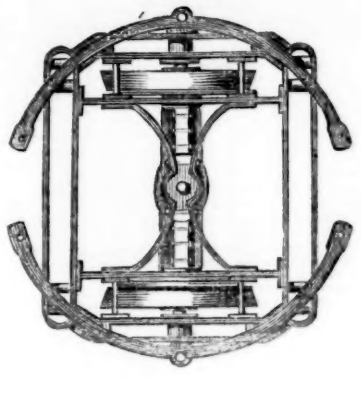


FIG. 13.

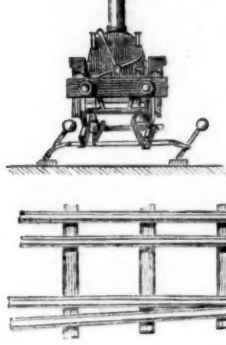


FIG. 9.

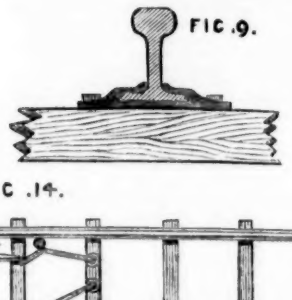


FIG. 14.

FIG. 10.

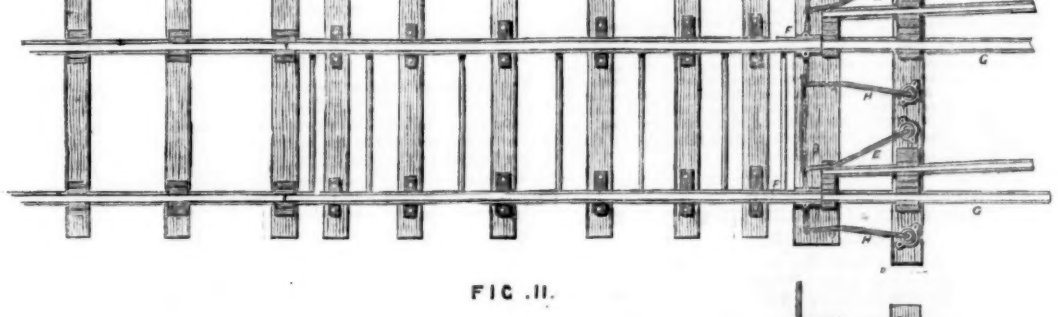


FIG. 11.

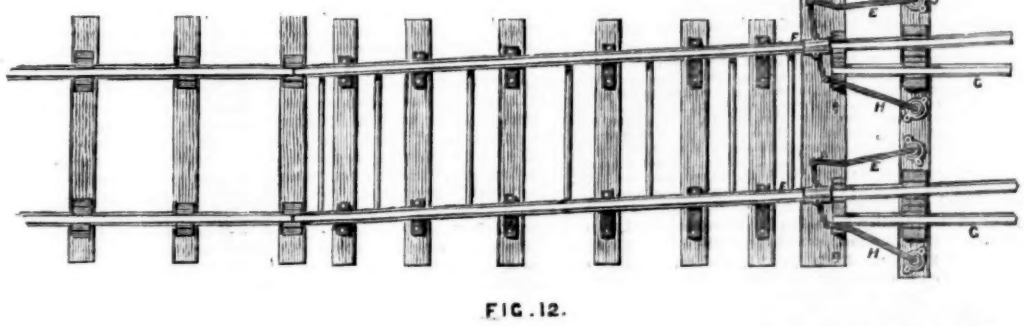
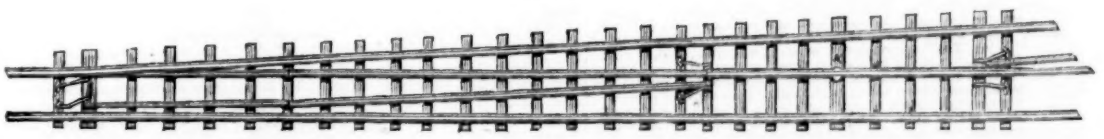


FIG. 12.

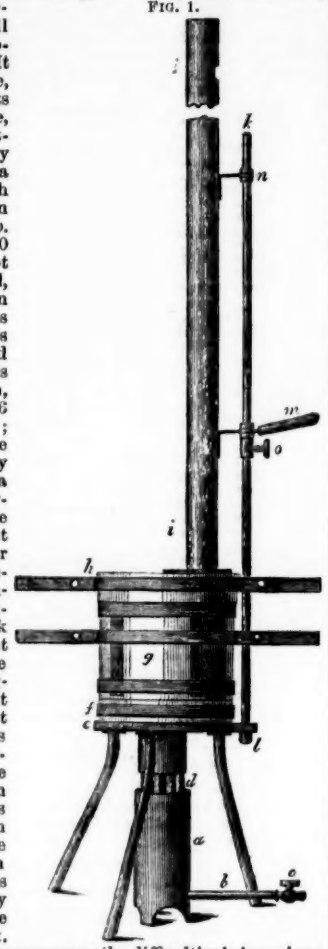


of the first carriage or engine shift it over, either to form part of the main line or part of a branch or siding. The apparatus may be made to act in either direction, and may be fitted singly or in pairs, for both up and down travelling; when a single apparatus is fitted to act in one direction only automatically, it can be shifted in the other direction by hand. In mines and collieries, as well as upon branch railways, where the smallness of the traffic necessitates the utmost economy of working expenses, the Tiranoff system offers great advantages, and will, no doubt, be extensively adopted as soon as its merits become better known.

NEW GAS FURNACE.

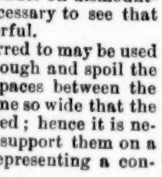
An improved gas furnace for chemical operations at a white heat without the aid of a blowing machine, has been designed by Mr. CHARLES GRIFFIN (of Messrs. J. J. Griffin and Sons, philosophical instrument makers, of Garrick-street), which appears admirably adapted for laboratory purposes. The furnace is small and portable, easily put together and taken asunder. It demands no blowing machine, and only a small chimney, acts without smoke, dust, or noise, and developes sufficient heating power to raise a 4½-in. clay crucible filled with metal to a white heat. Commencing with a cold furnace cast-iron can be fused, and cast into a 2-lb. ingot in 70 minutes, or in 40 minutes if the furnace be hot at commencing. Silver, gold, and copper can be fused in larger quantities, and in less time. The furnace, which is represented in the annexed diagram, consists of a brass cylinder, *a*, open at the bottom, and into the top of which 16 Bunsen's burners are fixed; gas being supplied near the lower end of the cylinder by the pipe, *b*, furnished with a stop-cock, *c*. A jacket surrounds the upper part of the Bunsen's burners, but is cut away at the bottom, in order to permit air to pass up between the burners. The consumption of gas by this compound burner, when at work in the furnace is 33 cubic feet per hour. In a gas furnace supplied with air by a blowing-machine fusion at a white heat can readily be effected; but the complaints of the defects of such a furnace are very frequent. The blowing-machine is expensive, cumbersome in the laboratory, and requires constant labour and attention during the whole time the work is going on; in addition to which the noise produced is considerable, and is felt by many to be a great annoyance and interruption to other work.

FIG. 1.



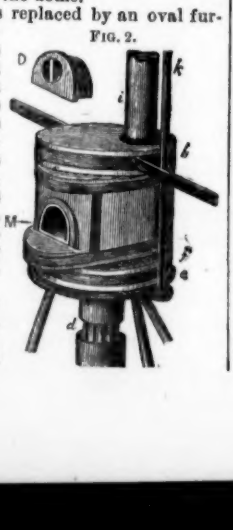
The mode in which Mr. Griffin overcomes the difficulties is ingenious. The furnace is supported upon an iron stool, *e*, and from this an iron rod, *k*, rises, to which the chimney, *i*, is attached. Upon this iron stool a fire-clay sole-plate is placed, the system of burners being closely fixed in a perforation made in the plate for that purpose. In a cylinder, *g*, 6 in. high, 8 in. in internal diameter, and 5 in. in bore, the crucible to be heated is supported on a perforated plumbago cylinder, which is shown in perspective, and to secure the greatest heating power the bottom of the crucible should be fixed at 1 in. to 1½ in. from the face of the bundle of gas burners. The crucible must be conical, not barrel-shaped, in order that the flame after striking the crucible may have space to escape through the holes in the plumbago cylinder. The space between the plumbago cylinder and the furnace cylinder should not exceed ¼ in.; increase of space here lessens the heating power of the furnace. The dome, or roof of the furnace has an outlet, so made that the flame in rising from the body of the furnace is bent twice at a right angle before it passes into the chimney. The chimney is 4 feet long and 2 inches diameter, and is movable around the rod by a handle. By this arrangement the chimney can be set on the furnace, or moved aside, with facility. This movement is sufficient when the furnace is used for simple fusions, or when no deleterious gases are driven off, but when arsenic, sulphur, &c., are expelled during an operation, and the entire apparatus cannot be placed under a hood, or fixed chimney, then the upper end of the chimney should be passed into a vertical branch of the knee-piece, the horizontal branch of which is connected with a fixed flue, and the chimney should be raised within the knee-piece by moving upwards the stop on the rod. A rise of about 6 in. is necessary to make room for the removal of the dome and cylinder on dismounting the furnace to remove a crucible. It is necessary to see that the draught of the fixed chimney is not too powerful.

The method of mounting crucibles already referred to may be used for 4½ or 4 in. crucibles, but smaller sizes slip through and spoil the draught, and if a smaller cylinder be used, the spaces between the plumbago cylinder and the furnace cylinder become so wide that the effective heat of the furnace is greatly diminished; hence it is necessary, when small crucibles are to be used, to support them on a grate made of fire-clay, the annexed diagram representing a convenient form; its diameter is 6 in. This grate is placed upon the sole plate of the furnace. The crucible is set upon it, and is surrounded by a smaller fire-clay furnace cylinder—one that measures 5 inches in height, 6 inches in external diameter, and 4 inches in bore. The same dome can be used with both cylinders. In the small furnace platinum and porcelain crucibles can be heated in fire-clay crucible cases. Operations that succeed at moderate temperatures, such as the fusion of zinc in an iron pot or ladle, are performed without using the dome or chimney. Access to the crucible in the furnace is gained at any moment by turning aside the chimney and lifting the dome.



When the furnace cylinder *g*, Fig. 1, is replaced by an oval furnace body that contains a muffle, as represented by M, in Fig. 2, all other parts of the furnace remaining as represented by Fig. 1, the usual muffle operations can be performed, such as cupellation, the roasting of ores, the combustion of organic bodies for their ashes, the burning of filters, &c. The muffle belonging to this furnace measures 7 in. in length, 3½ in. in width, and 2½ in. in height. It requires a bright red-heat, sufficient to melt silver, gold, and copper. This heat can be kept steady and uniform for hours; and being free from dust or soot, is particularly suitable for such operations as annealing.

FIG. 2.



Neither the burner nor the fire-clay fittings are claimed to be new, but the arrangement is made with increased care, and the necessity of a blowing-engine is entirely dispensed with.

The Royal School of Mines, Jermyn Street.

MR. WARINGTON SMYTH'S LECTURES.

[FROM NOTES BY OUR OWN REPORTER.]

LECTURE LII.—The natural ventilation described in my last lecture (said Mr. SMYTH), which is sufficient for small metalliferous mines, and which alone is used in many, is insufficient when we come to large workings, and the labyrinthine openings and galleries of an extensive colliery. The same principle is, however, still kept in view when arrangements are made for the latter. In natural ventilation the difference in the length of two shafts is sufficient to cause the air to descend by one, and to ascend by the other; but when large areas are dealt with the current of the air requires to be quickened. One of the most efficacious modes of effecting this is by the application of heat to the upcast column, which, being thus rarefied, rises with great rapidity, and creates a draught strong enough to draw the air from the most distant parts of the workings below. Of course the air will have to be properly directed, but of that we shall speak presently. Furnace ventilation is now generally adopted in England, following the example of Belgium, where it was in vogue long before it came into use here. In early days, and even now in small mines, the furnace was placed at the top of the shaft, and in that position no doubt did good service, but it was soon found that it was more effective at the bottom, an arrangement whereby the whole column of air in the shaft is heated. The placing of the furnace is, however, a matter of great importance, and requires care and consideration. First, it must be so placed or so guarded that no risk is created of setting fire to the surrounding coal, or of endangering the security of the shaft. In fiery mines it must be placed so that the explosive gases cannot reach the fires. Where no danger of this sort exists it is not unusual to carry the return air through the furnace, and it is then placed best at the lowest possible point. Where the seam is fiery it is found safest to conduct all the return air into the shaft without going near the furnace, and to feed the latter for the maintenance of combustion with fresh air brought down from the surface. It not unfrequently happens that the upcast shaft is used not only for ventilation but for winding, and then the furnace must be placed back at a distance of from 50 to 100 yards from the shaft, in order to prevent danger to the ropes and guides, and to avoid other dangers. When the furnace is so placed the drift from the furnace to the shaft must be made to have a gentle inclination upwards, so as to facilitate the passage of the heated air and smoke generated. In ordinary cases the ventilation is most effective when the returns can pass the furnace, and, therefore, that plan is always adopted when safe. In a large mine it is generally found that some parts are more productive of carburetted hydrogen than others, and it frequently happens that a drift is carried into the shaft from a suitable point in the return ways, by which the returns of any particular section may be conveyed away without going near the fire. When, however, the whole of the returns of a colliery are charged with explosive gases, the furnace must be fed from the surface, as I have already mentioned, and in these cases the end of the dumb drift ought to be at least 50 ft. higher than the end of the furnace drift. It sometimes happens that the returns are so charged with carbonic acid gas that the combustion would be greatly interfered with and hindered if they passed through the furnace, and in that case it may also be necessary to feed the furnace from the surface.

The velocity of the current of air through a mine—that is to say, the efficiency of its ventilation—depends primarily upon the heat generated by the furnace, although it is also greatly affected by the distance it has to traverse, and the obstructions it has to overcome. Great attention has, therefore, been paid to the construction of the furnaces and their grating, so that the combustion may be as perfect as possible. The furnace varies in size, the older varieties being from 5 to 10 ft. in width, with fire-bars about 6 ft. in length; but an improved system is now coming into use, in which the bars are more than 20 ft. in length, so that the fire may be shifted from its usual place, and thus interruptions to the work for the purposes of cleaning are avoided, and the size and therefore the power, of the fire may, if required, be increased. The fuel consumed is generally what is termed "small coal," and it ought to be supplied frequently, so as to form a "thin" fire through which the air can pass, and the combustion be rendered perfect. It is no unfrequent thing to see fires "banked" up, as it is called, and not touched for a considerable length of time—a practice which proves that the man in charge of the furnace is either ignorant of his duty or negligent. When properly managed a temperature of from 150° to 160° Fahr. may be kept up, giving a difference probably between the upcast and the downcast shafts of 80°. The temperature of the upcast is sometimes considerably modified by the dropping of water, which has a cooling effect, and by the ascent and descent of the cages when drawing is carried on in the same shaft. Thus, to get the full benefit of the furnace the shaft should have a good brick lining, and be kept as dry as possible. When carried out in an effective manner the quantity of air passed through the workings of a large colliery is very great and very rapid, varying according to circumstances from 100,000 to 200,000 cubic feet per minute—a quantity mostly sufficient to sweep away all deleterious gases, and keep the atmosphere in a healthy state. We must, however, bear in mind that this implies a proper distribution of the air, as without that large areas may be left what is called "dead," and notwithstanding the enormous volumes of air passed through the shafts, the ventilation be imperfect and bad. It is calculated that 100 cubic feet of air per minute is necessary for the health and comfort of each person underground, but if fire-damp be present many times that amount would be required. It is, therefore, obvious that the current of air must be large; that it must be carried to every working place, and along every drift or gallery, the intricacy of which creates so much friction, and offers so many obstacles, that it must also have an initial velocity of considerable amount.

Admirable, effective, and simple as the furnace is, many efforts have been made to find a more excellent ventilating power. Amongst the earliest of these was the application of jets of high-pressure steam directed upwards from the bottom of the upcast shaft. Mr. Goldsworthy Gurney was one of the earliest advocates of the steam blast, his plan for which in 1835 he laid before a Committee of the House of Commons, but in practice it was not so effective as was expected. Then came the suggestion that the steam should be divided into a number of jets, which was found to answer better. It was tried at the Seaton Delaval Colliery in 1848, and careful experiments made to test its comparative value. These are fully reported in the Transactions of the North of England Institute of Mining Engineers; and the result was that steam jets were found to be inferior in effect to the furnace, and that, too, with an increased expenditure of fuel to the extent of three to one. As an auxiliary to the furnace, it was also considered ineligible and inefficient.

LECTURE LIII.—We have to-day (said Mr. SMYTH) to pass under review some of the mechanical means employed in the ventilation of mines. We have seen that jets of high-pressure steam have been tried, but although much was expected from the piston-like force given out from a small aperture, and expanding into the form of an inverted cone, the results were not equal to those produced by fire, although there is no doubt that sometimes as an auxiliary, or as producing ventilation under circumstances of difficulty and risk, it may be of importance. Thus, in re-opening abandoned mines, in which there are accumulations of fire-damp, or perhaps in the early workings of fiery seams, its application might be useful. I do not intend to examine all the methods proposed (of which there are models upstairs, and many of them not a little curious), but will notice only some of those which have been brought into regular use. Amongst other mechanical means the most simple, and one which may often prove extremely useful, is that of a fall of water. If water falls into a shaft it beats down the air before it, and cools it also. If, therefore, in a pit there should happen to be an explosion, producing a total stagnation of air, and consequently a necessity for the production without delay of a current, it may be desirable to throw a quantity of water down the shaft, and this method is almost invariably adopted after accidents, which render it inexpedient to light the fire or ventilate by ordinary means. A considerable influx of this kind may be felt for hundreds of yards from the pulsation of the air. In the same way a large bucket or a cage, passed up and down with rapidity, will set the current of air in motion, or on the contrary it may stop it. Expedients of this kind, however, which may be beneficial in some cases, and dangerous in others, must be used with discretion. In some parts of Europe a fall of water is used for the purpose of conveying a blast to the furnace. This is the case in the Southern Pyrenees, where the air is carried in with the water, and passed into a square box, from which it escapes through an orifice at the side, and is led by a pipe to the furnace, while the water flows away at the bottom. The great advantage of an arrangement of this kind is its simplicity and inexpensiveness, and it throws a pleasant coolness into places where the ventilation is imperfect. Then there are a great variety of air-pumps employed in mines, many of which re-appear from time to time as novelties, when if people would only look back to old books they would find they had been employed in mines centuries ago. Amongst these may be reckoned the whole class which work on the bellows principle, of which there are a considerable number described and drawn in the ancient work of Agricola. They are, however, unfit for any but very small portions of the workings. The air is driven through a small nozzle, and though these machines may be used with great facility, the amount of air they introduce is necessarily small.

In the Hartz mines a sort of air-pump is a good deal made use of, and in the western parts of this country a modification of it is called the duck machine. Having described this by a drawing on the board, Mr. SMYTH said it may be used for driving in good air or drawing out bad air, but the latter is the purpose for which it is mostly patronised. It is attached to the pump-rod, and makes the same "excursion," as French engineers would say, and so gets rid of the foul air which accumulates at the ends of workings in metalliferous mines. In collieries it is an expedient which, however good in principle, is obviously insufficient, although in Belgium air-pumps of this kind are put up, with cylinders as much as 10 or 12 ft. in diameter; and the valves being so very large have to be fitted with counter-balances attached by strong levers. This has been found so great an objection that a plan has been introduced precisely similar to the old Hartz pump, in which the piston is made to work in an inner cylinder within a larger one, which is kept full of water.

From this system the march of invention took a great step forward, and the plan of M. Struvé came into use, and is worked on a large scale in the Welsh districts. His piston is a close-topped wrought-iron bell, of 12 to 22 ft. in diameter, working up and down in water, and by means of ranges of valves above and below it, placed in the walls of the piston chamber, drawing in and forcing out air at each up and down stroke. These machines are usually composed of two such pumps, worked by a steam-engine, and are capable of passing 20,000 to 100,000 cubic feet of air per minute. Another kind, differing chiefly by the piston being worked horizontally, was introduced by M. Mahaux. The scale of these are greatly surpassed by a remarkable machine erected at the Navigation Pit, Aberbare, by Mr. Nixon. Its sheet-iron pistons, 30 by 22 ft., or no less than 660 ft. area each, are supported on wheels traversing on rails a stroke of 7 ft. The chambers are fitted as in Struvé's machine, with flap valves 16 by 24 in., and 672 in number. At nine strokes per minute the quantity of air expelled would be 166,000 cubic feet per minute. There is no machine of this kind, however, which has not a large amount of leakage, but even if we take off 10 per cent. the quantity of ventilation is extremely large.

The next kind of machines to be noticed are those on the fan principle. These are largely employed not only in mines but in foundries. In the former they are extremely valuable for the purpose of blowing air into the close ends of workings, or extracting air from such places. The sort of fan so used is a wheel, with vanes placed radially. Machines of this kind have a great drawback. They must be turned at a great velocity, and when anything happens to reduce that velocity the ventilation would at once be interrupted.

Another apparatus of great importance is that of M. Lemielle. It is an ingeniously constructed machine, and in high favour in the French and Belgian collieries. In this country there is one at Ashton Vale pits, near Bristol, working in an admirable manner. Within a large cylinder of brick, wood, or sheet iron a smaller drum is placed eccentrically, and made to revolve. On the surface of this drum are two or more valves or shutters, which, by means of iron rods moving freely round an elbowed axis in the centre of the large cylinder, lie close to the drum in one part of the revolution, and open out in another.

An excellent fan ventilator is that of M. Fabry, which is somewhat peculiar. It has two axles, fitted each with three blades, which in large machines are as much as 10 ft. broad, and the axles being made to revolve in opposite directions, the blades almost touch each other in passing. By this means the air is taken into the machine at one side, and expelled at the other, and an effective ventilation is produced. It works at a slow velocity, and being very durable is much patronised in certain districts, where they are often constructed on a large scale, with drums (say) 20 ft. in diameter.

Another admirable exhausting fan is that of M. Guibal, a Belgian inventor, which has also been erected on a large scale not only on the Continent but in some of the Northumbrian and Durham collieries. It is somewhat remarkable in its appearance, inasmuch as it has a trumpet-shaped chimney, which expands outwards, and so counteracts the loss due to the high velocity given to the air by the vanes. The vanes, eight in number, are interlaced and are capable of being driven at a speed of from 150 to 200 revolutions per minute. The machine is enclosed in walls, outside of which is the engine which drives the fan, and in the other is an inlet connected with the upcast shaft. An arch is carried over the vane, beneath which the vanes have about 2 in. clearance, and attached to it is the trumpet-shaped funnel, but within the arch is a shutter, by means of which the volume of air drawn by the fan can be regulated so as to suit the exigencies of the colliery. The fans on this principle used in the North of England are 18 ft. in diameter and 4 ft. wide, and pass about 40,000 cubic feet of air per minute, with 80 revolutions. They are worked with an extremely small expenditure of steam. The engines having 8-in. cylinders; at 40 revolutions per minute they are found to pass an amount of air sufficient for good ventilation. It has been proved by experiment that at 41 revolutions per minute 23,000 cubic feet of air is passed; at 57 revolutions, 60,000 cubic feet; and at 64 revolutions, 100,000 cubic feet of air are produced. At a colliery in South Wales, where the machine is 29 ft. 6 in. in diameter, and the steam-engine having a 24 in. cylinder, 138,000 cubic feet of air are passed, with 68 revolutions per minute.

With results like these it is obvious that machines of this character will prove of the greatest advantage under certain circumstances. Where the pits are shallow the furnace may have some advantage over them, but when a shaft cannot be spared in order to devote it solely to ventilation, mechanical agency is most valuable. The machines I have described will move the air in large bodies steadily, and at a low velocity, and the time may come when mechanical contrivances such as these may supersede the furnace in a great number of mines.

[The Lecturer illustrated his remarks by a number of working models, as well as by drawings on the board.]

LECTURE LIV.—The first point of importance (continued Mr. SMYTH) in obtaining a suitable ventilation of mines is, of course, setting in action a sufficient force to move the intake current in one shaft, and the out going current in the other, and this we have seen may be done in various ways—as, for instance, by a furnace, which is the mode chiefly used in this country, and various mechanical apparatus which have been invented within the last few years, and of which several kinds are applicable to the ventilation of very extensive workings. I have mentioned the air pumps used in the Hartz; and Struvé's machine has been largely at work in the neighbourhood of Swansea. I next described M. Lemielle's invention as a more recent plan, which is already in action in this country, and the centrifugal fan of Guibal, which first made its appearance at the Exhibition of 1862, in the shape of large and well executed drawings, and although it was then made sufficiently clear that it was an admirable machine, several years elapsed before it became practically known in England. Machines of this class are now constructed of extremely large dimensions—as large, in fact, as possible consistently with their convenient application to mines, so that in cases where a greater amount of ventilation is requisite it may be obtained by applying them in addition to the furnace. Those who wish to study the questions of comparative economy and efficiency, raised by the application of these machines, will find ample materials in the 16th volume of Transactions of the Northern Institute of Mining Engineers. They will there find a number of plans and diagrams, and calculations to show the amount of work to be got out of them under certain conditions—conditions the value of which you cannot fully realise until you have seen the various modes of measuring the air which passes through a mine. The 16th volume gives the results of a number of experiments made in 1867; and since then other papers have appeared, and particularly in vol. 19, part 1. There are other kinds of centrifugal fans, but I have only described those which have been tried on a sufficient scale to show how far they are preferable to others proposed for the same work. In whatever way, however, we may get our motive power, that does not of itself constitute good ventilation, for there may be a hurricane of air passing down one shaft and up another, and yet the workings may all be lying "dead"—that is to say, unventilated.

The annals of mining record a frightful series of accidents which have taken place in mines when the ventilation of a large area has been attempted by means of a single shaft, divided with a brattice, the air passing down on the one side of it, being conducted to the workings, and then brought back to the shaft, the return air being discharged on the other side of the brattice. Under this arrangement it is obvious that if anything occurred in the shaft, as, for instance, the collision of two cages, or a fire, so that the brattice or even a portion of it were destroyed, the air would pass at once from the one side to the other without going into the workings at all. This in a smaller degree occurs in the mine itself where the stoppings are interfered with by accident or explosions, and the same thing will also take place if the air be carried to too great a distance, so that it will no longer attempt to take the shortest course to the outlet. If we refer to the map or plan of a colliery, as they were worked in former days, and up to the beginning of the present century, we shall see that the ventilation was only carried where the work was going on, and all the other parts of the mine were left dead and stagnant; in which case if at any one part of the goaf a fall of roof occurred the gases were often driven out to an extent which vitiated all other parts, and caused tremendous explosions. The necessity, then, for a proper "distribution" of the air is palpable. This is done chiefly by stoppings of various kinds. The air will naturally take the shortest course to the point at which it can escape to the surface. If the air, then, is conducted down the shaft it will pass along the nearest gallery or drift to the upcast. If that drift be stopped it will then pass on to the next, and in this way it may be taken over the whole area of a very large mine. The stoppings or doors are of various kinds, according to the places and purposes for which they are wanted. Thus, when at a great distance from the shaft it is necessary to put in solid brick walls instead of doors, which would suffice at a shorter distance. These are sometimes merely "stowed"—that is, built up with loose material obtained in the workings; but in that case it is necessary to have such stoppings continually looked after, as they are apt to fall, and thus to occasion serious leakages, which will interfere with the proper conveyance of the air into the parts beyond the fallen wall. Sometimes a brick wall is put in, and then a mass of attle some yards in thickness heaped before and behind it, so that if an explosion took place the wall in the centre might remain uninjured. On the other hand, if the stopping is unprotected in this way, and consists only of a thin brick wall, it is liable to be blown down by even a moderate explosion, and cases are numerous in which the stoppings being blown out, and the ventilation destroyed, great loss of life has ensued. It is in such cases that the after-damp is found to be so fatal, as no atmospheric air passes to counteract its efforts, and all living creatures within its influence die. In practical mining, however, it is found necessary to construct the stoppings so as to enable the miners to pass through from one part to another; and of the doors used for this purpose several kinds are employed.

1.—When near the shafts, and communication between the bottoms of the downcast and the upcast is necessary for the traffic of the mine, or if for no other purpose to convey fuel to the furnace, and to allow the manager to pass through, strong doors are put in the full size of the drift. These are called main doors. When single they are made to open against the pressure of the current, and are thus kept closed; but they ought always to be placed in pairs, at such a distance that one door may be closed before the other is opened, so that no air may be lost—acting, in fact, as an air lock. There was a disastrous explosion at a place called Talke last year, which resulted entirely from the absence of a second main door. It happened that an accident occurred to a truck as it passed through the main door, which in consequence could not be closed for a considerable time. The ventilation was, of course, cut off, as the air, instead of going its customary route, rushed through the open door, finding thereby a nearer way to the upcast shaft, and so left all the rest of the mine without a supply of fresh air. In large workings, where it is thought unwise to trust to the quickness of those entrusted with the duty of closing the doors, three are put up. This not only prevents leakage, but if an explosion takes place, which generally carries away the doors, one at least may withstand the blast. It has been proposed to make the "main door" to swing from the roof of the level, so that the blast might not destroy it, but only raise it as it passes, and then let it swing back into its ordinary place. A more ingenious adaptation of this idea is that which proposes that besides the ordinary main doors duplicates should be made and attached by hinges to the roof of the level at one end, and the other held up by a flap-board, so that in the event of an explosion strong enough to carry away the doors, it would also carry away the flap and let the supplementary door down, so as to restore the current, and yet swinging freely on its pivot, it would allow the men to escape through if necessary. I am not aware whether this plan has been much employed, but in theory it seems unexceptionable as a safeguard. Another protection in case of explosion is the provision of strong door frames at suitable points to receive temporary doors, which it was suggested (and examples shown) at the Exhibition of 1862 should be made of sheet iron instead of wood. These doors, when placed where a constant traffic is kept up, are opened and closed by persons posted at them for that purpose. Attempts have been made to make them self-acting—that is, self-opening and self-closing. These, however, when brought into use are open to the objection that the manager can never feel absolutely certain of their always being in order, and then the consequences would be extremely serious, and probably cause an explosion. It is, therefore, considered safer to employ human agency instead of mechanical means, however ingenious, to open and shut doors of this kind; and in spite of the humanitarians who are crying out for a law to forbid the employment of small boys, there are a great many in every mine who do nothing but open and shut doors. No doubt it is dreary work to sit by a door for hours in the dark, but the work is one of importance, as the safety of the mine and all within the workings depends upon its proper performance.

2.—Sheth doors are commonly employed in those parts of a mine where brattices are used to convey the air to the workings, and are placed in the brattices to enable wagons which cannot follow the course of the air round the brattices to be pushed through. The brattices used in the workings are of a temporary character, and are formed very frequently, as I have before mentioned, of a sort of cloth or tarpauling, spread on a light frame. It is run along the centre of the drift, and the air is thus conveyed from the main air ways along one side

of the drift to where the men are at work, and away on the other side; and being so entirely of a temporary character the miners are often too careless in putting it up so as to avoid leakage, and the sheth doors are seldom made to fit accurately, and sometimes a portion of the sheet is removed instead of a door.

3.—Another sort of opening is called a "man door." It is employed in collieries where it is not desirable to keep open communications between one part and another, but where it is necessary sometimes for the manager to pass, in order to save time and the labour of travelling an enormous distance. These are strong doors put in the stoppings, and should always be securely locked to prevent the men from getting through. These ought to be examined frequently to see that their integrity has not been tampered with.

4.—Sham doors are occasionally used to check the current of air, or to turn it in any given direction.

5.—In mines subject to spontaneous combustion "dam doors" are put in as precautions. They must be air tight to be effectual, as they are closed when a fire breaks out to shut it off from all access to the dangerous parts of the workings until the flames are extinguished. A fire produced by the spontaneous combustion which arises in the small coal of particular seams produces in a short time such a smoke and "stythe" that it can only be approached on the windward side, and frequently makes it necessary to retire to some distance and dam off or isolate a whole district. To meet such cases the frames of the dam doors should be prepared beforehand at suitable spots in the main drifts, and they then perform excellent service. There are peculiar conditions in the under sea collieries at Whitehaven, which render them remarkably liable to spontaneous combustion, and the Earl of Lonsdale most judiciously has had the lintels and posts of dam doors prepared in the stone drifts between faulted districts of coal. On a particular occasion after one of these fires, about six years ago, in the new or Forster's district, it was particularly remarked how completely all danger was obviated by the facility with which the fire was isolated by means of a most efficient management of dam doors. In certain coal pits fires are apt to be caused either from some incautious act connected with the explosion of gunpowder, or with the ventilating furnace, besides the spontaneous combustion of small coal, which I have just alluded to; and there are cases in which dam doors are not sufficient, and it is necessary to wall off, possibly, a whole district, in order that the workings in the other districts of the mine may not be stopped. There are several mines in which at the present time the coal is burning, and continues to burn in spite of all efforts to extinguish it; and there are some well-known cases in which the coal has been burning for centuries. It is, therefore, of the highest importance that incidents of this kind should be met in their earliest stage; and the application of thoroughly air-tight and well-constructed "dam-doors" may possibly stop a fire of this kind at the outset, which, if neglected, might destroy a colliery.

WORKMEN'S GEOLOGICAL EXCURSION.—One of the pleasant and instructive "outings" which the Workmen's Club and Institute Union is in the habit of arranging for its members, took place at Woolwich last Saturday. About 90 workmen, members of the London Institutions, met Prof. Tennant, the geologist, who very kindly gave his valuable services on this occasion, as he did last year. Two of the chalk-pits near Woolwich were visited, and a large number of fossil shells were discovered by the visitors, who were equally surprised and delighted at the revelations of the past history of the world, thus made to them *in situ*.

MINING IN AUSTRALASIA—MONTHLY SUMMARY.

FORD'S ROCK-BORER.—Captain Warren, of the Paramatta, has written to the Hon. W. Morgan, a director of the mine, as follows, respecting Ford's rock-boring machinery:—"We made a start with Ford's rock-borer at the 32 fm. level, and, as far as boring is concerned, with perfect success. Of course, we are all strangers to the machine, and found it difficult and tedious to adjust; but when once set right the rate that it sinks a hole is surprising. The first hole that it bored was in the 32 fm. level end of No. 3 shaft (which we are now paying 45*l.* per fathom for driving). In the bottom part of the end it only required a shallow hole about 14 inches, and I am certain that the time occupied in boring that distance did not exceed two minutes. The next hole we bored higher up the end to a depth of 20 in. This hole bored harder, and blunted two drills, which caused some delay in changing them; but I don't think the time in actual boring exceeded six minutes. The third hole I bored in the bottom of No. 3 shaft, which was done with equal rapidity; and I believe that it will be in sinking this shaft that we shall find the machine most useful. The air machine kept the pressure in the boiler at 80 lbs. to the inch, everything being tight and worked well." Although Capt. Warren had not seen one of these machines before, and as the motive power, compressed air, necessarily made much of the mechanism of the works quite novel to him, he managed, though the machine reached the mine not put together, but each piece packed separately, to get it into working order, and, as will be seen, to accomplish the task for which in was intended.

THE GOLD FIELDS OF VICTORIA.—The papers brought by this mail present a favourable report of the gold mining industry in the colony of Victoria, notwithstanding continued depression at Ballarat, the metropolitan gold field. The Sandhurst district, the second in importance, is doing well. The district of Berlin, which during the last 18 or 20 months has surpassed any gold field hitherto discovered for the heavy character of its gold, and has earned for itself the name of the "Nuggety Diggings," has given another proof of the richness of its ground. A lump of gold has been found there by two men in a claim which weighed 93 lbs. 5 ozs. 15 dwts., regarding which and Berlin generally a local paper writes as follows:—"Its weight is 90 lbs. 5 ozs. 15 dwts.; length, 12 in.; height at highest solid part, 6 in.; at lowest, 4 in.; circumference of centre, 18½ in.; circumference of small end, 13 in.; of large end, 19 in.; circumference lengthwise, taken by the sides, 32¾ in.; by the top and bottom, 28 in. It was found by Mr. Solomon, a storekeeper, and his son-in-law, a working mate, in a claim situated in John's Paddock, not far from Mr. Solomon's store. Berlin was opened towards the latter part of 1868, and since that time—a period of only two years—the following nuggets have been unearthed, besides some thousands of smaller ones, of which no note is kept. Two weighing 15 lbs. each, one of 17, one of 19, four of 20 each, one of 22, one of 24, one of 27, two of 40 each, one of 43, one of 50, one of 67, and now one of 93 lbs. It is a curious circumstance in connection with Solomon's claim, that it had been worked by several parties previously, none of whom had been able to make it pay, and it had been offered for sale to the Chinamen, who, however, refused to buy, as they stated it had been no good to Englishmen, and would, therefore, be no good to Chinamen, and Solomon had to work it himself, because he could get no one else to do so on satisfactory terms. It is not often that lumps of gold of any large size are obtained in quartz reefs, but a very welcome find of this nature has been made in the claim of the Argus Company, situate in Sailors' Gully, in the Sandhurst district. The specimen when unearthed weighed 24 lbs., and when beaten up and retorted it returned 15 lbs. weight of gold, or 180 ozs., of the value of over 700*l.* A nugget has been found in Castlemaine district weighing 215 ozs. It was sold to a bank by a small party of men, who declined to give any clue to the place where they found it. Some new gold workings have been discovered on the New South Wales side of the River Murray, at Mittagong, about 50 miles from Victoria, at which, according to the latest accounts, about 400 men were working, with fair prospects of success. A payable gold field has, it is thought, judging from reports, also been found on the Talgarno run, about 15 miles from Wodonga, on the Victorian side of the River Murray."

A nugget of 10½ oz. pure gold was picked up by a boy near Winter's Freehold, Ballarat, and one of 60 ozs. in Mopoke Gully.

"Nuggets," says a Ballarat paper, "have been over and over again picked up from the quartz metal laid down in our streets, but on July 4 a bigger piece of luck than usual fell to some boys in Rubicon-street, near Winter's Freehold. They were shying some quartz stones from the street at an old boiler by the road-side, when one of the boys picked up a mass of golden quartz containing 10½ ozs. of pure gold." As a companion picture of good luck to the above, it may be mentioned that a fossicker at Little Bendigo, while in the act of carrying some 7 dwts. of gold to Ballarat for sale, picked up a 6-oz. nugget in Mopoke Gully. A Sandhurst paper reports the discovery recently in the Golden Pyke Company's ground of a reef, not very thick, but which may almost be said to be more gold than quartz; very heavy pieces of solid gold, over 7 ozs. in weight, have been taken out of it. Berlin, the field of nuggets, maintains its reputation. A party of Chinese recently got 50 ozs. in two pieces. The ground is mostly held by Chinese, and consequently the finds do not all become known; but the way in which the Celestials carry on their gambling transactions shows that plenty of gold is being obtained. The accounts received by the last mail of "rushes" in different and distant parts of the colony encourage the belief that it is auriferous in the greater part of its length and breadth.

SYDNEY, JULY 13.—The rains and the floods have much interfered with mining at Mudgee. A sale of 121 diamonds took place on the 4th; prices ranged from 19*l.* each downwards. News has been received of the discovery of diamonds 25 miles from Fort Burke, on the Upper Darling. A party is reported to have brought into Mudgee, 10½ lbs. weight of smelted gold from Galgong.

ADELAIDE, JULY 16.—Mining matters at the gold fields have improved, particularly at Barossa. Cement producing at the rate of 10 ozs. to the ton has been found there. Steps are being taken to work for gold on portions of the Tungkillo special survey. The English, Scottish, and Australian Chartered Bank has during four years purchased 7191 ounces of South Australian gold at a cost of 27,685*l.* Copper mining was steadily progressing, new discoveries being made and the old mines vigorously worked. The Moonta Mine had declared another dividend of 10s. per share. The Wallaroo Company has lately added sixty to its staff of workmen.

BRISBANE, JULY 12.—The news from the gold fields continues satisfactory, although no very extraordinary yields are heard of. The total gold produced at the Thames during May was 11,059 ozs., exclusive of about 1000 ozs. remaining to be retorted at the commencement of June. The volcano at Triroga is in a state of active eruption.

GOLD IN WEST AUSTRALIA.—Messrs. S. Mangles and Co. write—"We have this morning received from our agent in Western Australia (Mr. R. King) a telegram, dated Galle, Sept. 5, announcing that a payable gold field has been found in the colony, near the Irwin river. For the information of your readers, the Irwin river is about 250 to 300 miles north of Perth, the capital of the colony."

AUSTRALIAN MINES.

YUDANAMUTANA (Copper).—The superintendent (Adelaide, July 18) states—"With regard to the railway to the northward, the business of the session has been postponed, in consequence of the treasurer's absence in Melbourne, at the Intercolonial Conference; but the railway question, which the Ministry are pledged to bring in early this session, will be amongst the first matters for consideration on the re-assembling of Parliament. Smelting has not been so satisfactory as I could wish to report. The furnaces since last mail have been comparatively idle, consequent upon the state of the country. During the wet weather no teams could travel, nor could we get in any sand, clay, or fuel; but as soon as the weather cleared up a little the wood began to come in. I am now having the sulphur ores calcined on the hill, in the open air, before smelting, using up in the process the bark and refuse of our wood piles. I can promise far better returns for July month.—Mining: Under this head the news is more cheerful than any I have reported since my management of the company's affairs here.—No. 1 Winze, 51 fms.: The lode in the bottom is about 3 ft. wide, solid black ore and yellow and purple sulphurets, widening as it goes down; the black ore is bagged as broken away. It is estimated that this lode will turn out 19 tons of 25 per cent. ore per fathom. In the case of samples sent home by this mail divisions Nos. 1 to 4 show the character of this splendid lode. The stopes under the 10 fm. level, at the 25, in No. 1 winze, are turning out some good smelting work. These stopes are in untried ground, and may lead to good deposits of ore." Capt. Terrel reports, under date July 11—"Blinman Mine: No. 1 Winze: I am pleased to say the lode is looking splendid, and is about 3 ft. wide, solid yellow and peacock ore, coated black, of 25 per cent. The lode will turn out 10 tons per fathom, at least, of this percentage, and my opinion is that it will be a great deal richer in a few fathoms than it is at present.—No. 2 Winze: The lode is from 9 in. to 15 in. wide, of rich horseflesh ore (see sample sent), and is underlying more to the north and north-west than formerly.—No. 3 Winze: The lode in this place is looking much the same as last report. The stopes south of No. 1 winze are also much the same as last report. The lode in the bottom of the 10, between No. 3 shaft and No. 2 winze, is looking very well; it is about 20 in. wide, of good carbonate ore. These are all the places which are at work at present. There has been an immense quantity of rain of late. The place has been under water for days together; the furnaces many a time could not be tapped; teams could not travel to supply us with wood, charcoal, sand, and fire-clay; nearly everything has been at a standstill. Such rain has never been seen before by any white man. I have been in the north now fifteen years, and I never saw the country in such a state. I have no doubt that as soon as the weather clears up a little we shall be able to make good returns." Ore raised from July 1 to July 11, 65 tons; smelted, 90 tons; on hand, 31 tons; copper made, 7 tons 17 cwts. 1 qr.

Mr. R. Lock, the secretary (Sept. 8) writes—The following intelligence has been received from Mr. Fiveash, the company's superintendent at Adelaide, by *telegram*, dated Galle, Sept. 6:—"Sulphuret lode now 16 ft. wide east and west, all solid ore of 30 per cent., still widening, length as yet undiscovered north and south—have cut hot water—splendid prospects for the company—hope fresh capital is raised, now indispensable."—[This message has been transmitted by the superintendent in the mode prescribed by the directors, to gaurd against fraud.]

PORT PHILLIP AND COLONIAL (Gold).—The quantity of quartz crushed during the four weeks of June was 3748 tons; pyrites treated, 43 tons. Total gold obtained, 840 ozs. 5 dwts., or on average per ton of 4 dwts. 11¼ grs. The receipts were 3141*l.* 2s. 5d.; payments, 3396*l.* 8s. 10d.; loss, 255*l.* 6s. 5d., which added to the debit balance brought forward from last month made a total of 5166*l.* 12s. 9d. to the debit of joint account. The following is the return for the first three weeks of July:—Quartz crushed, 3166 tons. Total gold obtained, 629 ozs., or an average per ton of 4 dwts.

— *Telegram* from the resident director, Mr. Bland, at Clunes, dated Galle, the 5th instant:—"Yield much improved: all going well."

ENGLISH AND AUSTRALIAN (Copper).—Port Adelaide, July 18: The quantity of coal at Port Adelaide was about 264 tons, besides 490 alongside wharf in the the Bosphorus, collier, now discharging. During the greater part of the month two smelting furnaces, two roasters, and one refinery had been at work. The smelting furnaces were let out on the 16th, but the roasters and refinery would be kept at work for about 10 days longer before letting all the furnaces out for the annual stock-taking. When the fires are re-lighted it is expected to begin with the same number, or perhaps one more. At Newcastle there were four furnaces completed, together with stack and culvert for six, the remaining two furnaces were being progressed with. The manager writes in reference to the wharf extension:—"The work is all but finished, as Anderson has only 14 feet of sheet piling to drive and to fix mooring chains and posts. Our spoon barges, those of the Government, and the Government steam dredges, are making good progress. The Glencoe, Bosphorus (collier), and the Claymore are now alongside." The 200 tons copper advised last mail as in course of shipment had been shipped, and in a few days there would be about 185 tons further copper for shipment.

ANGLO-AUSTRALIAN (Gold).—Capt. Raisbeck, Fryerstown, July 16: No 1 engine-shaft, present depth 155 feet, strata in shaft indicate proximity to quartz; touched a flookan with a little quartz on the 6th inst., tapped more water, stopped sinking and secured the ground preparatory to commencing sinking again with whim.—No. 2 Winze: We have extended the north drive 37 ft., quartz in end 18 in. thick. The whim will be completed to-day.

AUSTRALIAN UNITED (Gold).—Mr. Kitto, Fryerstown, July 16: On the Central Mine Mr. Kitto writes:—"After innumerable delays, owing principally to the continued downpour of rain, we have commenced washing, and have cleared off five machines of dirt for 20 ozs. of gold. From this time during the ensuing month we expect to wash one machine every day, and shall pay expenses. If all things go right, the profit during the following month should be 300*l.*, and continue to increase until we are in full work—say, four or five months. The thickness of the bed of wash-dirt in this mine is about 3 ft., it dips towards the centre of the property, and averages at present 2½ dwts. to the ton—a good yield, but one which we have every reason to believe will materially increase as we approach the centre of the gutter.—Duke of Cornwall Mine: The ground in the shaft (Dauke's) is much easier, and we shall commence cross-cutting at 260 feet in about a fortnight. I cannot see my way to reach 300 feet at present. I have every reason to suppose that I shall cut Rowe's shoot at the 260 ft. level. The people have a reef 75 to 80 wide, yielding (last crushing) over 1 oz. per ton, and averaging 15 dwts.

SCOTTISH AUSTRALIAN.—The directors have advices from Sydney, dated July 13, with reports from Lambton Colliery to the 8th. The sales of coal for the month of June amounted to 12,473 tons.

FOREIGN MINING AND METALLURGY.

The state of the Belgian coal trade is not so satisfactory as it was recently. The principal foreign outlet for Belgian coal—France—is closed for the most part, and from those districts which remain peaceful only a few small insignificant orders have come to hand. The Belgian coal trade is clearly doomed to pass through a certain period of stagnation, but the war once closed it would soon show a decided revival. On home account the demand is tolerably well sustained, and the supply of labour being comparatively limited there are nowhere any excessive stocks. Coke is everywhere sought after, and is easily disposed of. Washed coke is quoted at 1*l.* to 1*l.* 4s. per ton; unwashed ditto, 17s. 6d. to 1*l.* 0s. 10d. per ton. The Belgian iron trade has been reduced by the war to a somewhat precarious state. In order to give a slight stimulus, if possible, to industrial affairs, the Belgian Government is about to commence the construction of two forts, at Cruybeke and Zwyndrecht.

There has been scarcely anything passing in copper upon the French markets. At Havre, Chilian in bars is quoted at 66*l.*; Chilian in ingots, 73*l.* to 74*l.*; and pure Peruvian mineral, 70*l.* to 70*l.* 10s. per ton. On the German markets there is almost complete stagnation; at Hamburg transactions are limited to the immediate requirements of consumption. Upon the French and German tin markets quotations have been purely nominal. At Amsterdam, although the quantity of tin in the hands of the Society of Commerce, as well as the quantity under sail, is rather considerable, no material change has been produced in the market; almost the whole of the stock is in firm hands, and the large holders will not sell at present rates; on the other hand, the demand is somewhat limited. Banca has been quoted at 75 fls. Billiton has been more offered, several ships having arrived at Amsterdam with cargoes of that metal; sales might be easily effected at 72 fls. At Rotterdam the market has been a little more feeble of late; Banca might be purchased at 74½ fls., and Billiton at 72 fls. There is no material change to report in lead. Transactions in zinc are a good deal interrupted in Germany by the prevailing war. The Hamburg zinc market has been very quiet, and prices have been nominal. At Amsterdam, Silesian zinc has been quoted at 13 fls. to 13¼ fls.

Since the evil day for France upon which the French Government declared war against Prussia the price of coal in the departments of the Nord and the Pas-de-Calais has slightly advanced, and coal which in the early part of July was worth 12s. per ton now brings 14s. per ton. Some orders have been received in the Nord and the Pas-de-Calais from Alsace and the Moselle, which can no longer obtain coal from Rhenish Prussia, and have to meet their requirements accordingly elsewhere. It will be difficult, however, to execute the orders in question. The advices which reach us from the Champagne iron districts are somewhat better than might have been anticipated, having regard to the gravity of the events which have been transpiring in that part of France. Some establishments have, it is true, stopped working, but a good number of others are still applying themselves to their ordinary production, notwithstanding the occupation of the district by Prussian troops; what is produced is carried, however, into warehouse, as means of transport have completely made default, the railways being cut here and there, while the navigations are interrupted. At present a scarcity of coal has not made itself much felt, as large supplies existed formerly at the Champagne forges and blast-furnaces. But these supplies are not inexhaustible, and if they cannot be renewed a time will come when the works will have to suspend operations from a sheer lack of combustible. Orders are almost at an end, prices are nominal, and all that the trade can do is to watch the progress of events. In the Moselle much the same state of things prevails. MM. Viellard, Dollen, and Co. have just obtained a concession of mines of argentiferous lead in the communes of Mazerat-Aurouze, St. Etienne, and Jax in the arrondissement of Brioude; the Aurouze concession comprises a superficial area of 5320 acres. At Paris there has been scarcely anything done of late in iron; a slight fall has taken place in merchants' iron, and the orders given out are all connected with works in course of execution. Contractors who have on hand works the execution of which can be postponed are completely abstaining from giving out any orders. In the basin of the Loire a large amount of activity prevails. The works at Firminy, St. Etienne, St. Chamond, Assailly, and Rive-de-Gier are putting forth all their strength. MM. Petin, Gaudet, and Co. have received orders from the Government to make as many cannon, muskets, armour-plates, and bullets as they can possibly deliver. MM. Marrel Frères are making at present armour-plates to be used for the protection of mitrailleuses; forty of these armour-plates have already been dispatched to the North of France. MM. Jacob Holtzer and Co. are making muskets and bayonets at Unieux and at the Pont Salomon Works. The definitive constitution of a company which was in course of formation for the working of metalliferous bearings in the department of the Manche has been adjourned. The imports of pig into France in the first six months of this year compare as follows with those effected in the corresponding period of 1869:—

	1870.		1869.
Imported free of duty ..... Tons	81,567	.... Tons	68,968
" for shipbuilding	4,143	.....	836
" with payment of duty	1,912	.....	4,636
Total	87,622	.....	74,440

As regards iron and plates, the totals stand thus:—

	1870.		1869.
Imported free of duty ..... Tons	34,698	.... Tons	28,836
" for shipbuilding	4,020	.....	4,195
" with payment of duty	1,552	.....	1,414
Total	40,270	.....	29,445

The production of casting and refining pig in France in the first six months in this year compares as follows with the corresponding production of the same period of 1869:—

Group.	1870.		1869.
Ardennes ..... Tons	8,006	.... Tons	7,117
Brittany	7,691	.....	10,861
Centre	123,041	.....	142,922
Champagne	53,598	.....	55,080
Comté	24,119	.....	19,181
Escaut	54,635	.....	47,591
Gard, Bouches-du-Rhone, and Corsica ..	46,493	.....	48,381
Loire and Savoy	113,802	.....	116,274
Longwy	62,295	.....	58,639
North of the Moselle	79,602	.....	85,204
Sambre	32,629	.....	24,222
South of the Moselle and Meurthe	91,534	.....	64,021
South-west	9,876	.....	13,900
Aubin Works and Imperial Marine	7,577	.....	8,356
Total	714,892	.....	699,749

As regards rails, plates, and miscellaneous iron, the totals stand thus:

Group.	1870.		1869.
Ardennes ..... Tons	28,714	.... Tons	20,506
Paris basin	27,755	.....	26,063
Brittany	6,117	.....	6,937
Centre	100,394	.....	106,002
Champagne	45,835	.....	48,911
Comté	26,853	.....	26,908
Escaut	35,650	.....	36,284
Gard, Bouches-du-Rhone, and Corsica ..	16,024	.....	14,993
Loire and Savoy	74,495	.....	71,219
Longwy	3,549	.....	3,327
North of the Moselle	50,320	.....	50,926
Sombre	59,978	.....	50,467
South of the Moselle and Meurthe	18,074	.....	17,144
South-west	3,605	.....	3,643
Aubin Works and Imperial Marine	13,165	.....	13,998
Total	510,528	.....	497,328

The production of steel in France in the first six months of this year was as follows:—

Group.	Bessemer steel.		Martin steel.
Centre ..... Tons	7,290	.... Tons	8,664
Comté	670	.....	1,175
Gard, Bouches-du-Rhone, and Corsica	—	.....	1,233
Loire and Savoy	17,400	.....	31,626
South-west	—	.....	500
North of the Moselle	—	.....	1,021
Total	25,360	.....	44,219

The total production of steel of both descriptions in the first half of this year was thus 69,579 tons. The first half of this year was thus a progressive and prosperous period in the history of French metallurgy: the second half of the year has, unfortunately, proved a period of disaster and gloom.

FOREIGN MINES.

COLORADO TERRIBLE LODE.—Account of ore raised from April 15 to July 31, 1870:—

FIRST CLASS.—39 tons 13 cwts. 3 qrs., of which 17 tons 15 cwts., now in Liverpool awaiting sale, assays 565 ozs. of silver average per ton, and is worth 282*l.* remaining 21 tons 18 cwts., on the way to Liverpool from Denver.

SECOND CLASS.—90 American tons, of which 27·576 tons, treated at Georgetown, produced net $4001 32 c. = $140 10 c. per ton. At this rate, the account to the end of July bear out the agent's statement that he will be able to pay all expenses of mining from proceeds of second-class ore alone.

THIRD CLASS.—165 American tons; 50 tons sold to net $1200.

TUNNEL.—Progress made to July 31, 63 ft. 7 in.; total, 193 ft. 7 in. Rock extremely hard; advancement slow.

Agent's last advice, Aug. 19:—The vein ore in the second level drift has widened from roof to floor of drift, being at first 4 in. to 5 in., rich in ruby and brittle silver; expect produce for August to exceed that of July. Have let contract to stope in new third level stone.

BATTLE MOUNTAIN (Nevada).—W. Nancarrow, Aug. 17: Virginia Lode: The lode in the north level is 5 feet wide, a real good lode, but not quite so good as it was last week, but still opening a rich lot of ore ground; the last 20 feet driven here has been through the very best lode I have yet seen since I have been in the mine, and, so far as seen, we are on this lode opening up a rich mine. We have two stopes working in the back of this level—one north and the other south of the winze, both of which are turning out a splendid lot of ore, the best ever yet seen in this district. The south level at this depth is driven driven from shaft 25 feet; the lode is 4 feet wide, composed principally of iron, but of no value. Lake Superior is looking just the same as when I last wrote you; the air being still bad not much work has been done, but I hope in a very short time to be able to commence work here again. There is nothing new on the Hallow's lode since I last wrote you. We have now down at the railway station between 1900 and 2000 sacks of rich ore, which I shall send down to San Francisco, I hope, before this week is over if I can get cars to ship in on.—[The agents have made 11 shipments in the 12 months they have been working.]

EXCHEQUER.—Capt. Chalmers, July 25: During the week ending 23d inst. the north drift at the 50 in the winze, was in 42 feet; the winze was down 63 feet. The men on this shift were employed timbering chamber in the 50 for three days. Two shifts were grading foundation for the house, and two shifts on the road leading to the wood ranch.

— Capt. Chalmers, Aug. 8: During the week ending 6th inst. the north drift at the 50 in the winze was in 71 feet; the winze was down 73 feet. Two men were employed four and a half days and one man six days in grading a space below the house for a carpenter's shop, and for a "dump" for first-class ore under the shop.

PESTARENA UNITED (Gold).—Sept. 5: 682 ozs. of gold from 968 tons of ore for the month of August.

CAPE (Copper).—The directors have received despatches per Himalaya. Spectakel report describes continued good progress in laying open productive ground, and speaks well for the future prospects of the mine.—Return for June, 110 tons. The construction of the railway continues to make good progress. The pasturage and crops are in excellent condition, and transport is proceeding briskly. Bills of lading are received for 373 tons per Ocean King, and 600 tons per Tacna. Four hundred tons of ore, ex Glanrafon, have been sold by private contract at 12s. 9d. per unit.

[For remainder of Foreign Mines see to-day's Journal.]

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